The extension of the Scene Adaptive Coding of U.S. Pat. No. 4,302,775 from intraframe coding to interframe coding has proven very significant in terms of improving image quality and reducing bandwidth. These improvements, however, have created a need for improved coding systems for reducing redundancy and there continues to be a need for improved signal processing methods and apparatus for data compression systems.

SUMMARY OF THE INVENTION

The present invention is a signal processor and method for efficiently processing signals using ordered redundancy (OR) coding and any one of a number of different modes.

The signals to be coded are typically multiple values where the multivalued digital numbers, X(k) are typically the integers 0, 1, 2, 3, 4, . . . , and so on arranged in any order. Frequently, some values are repeated in forming digital numbers and hence the probable frequency of occurrence of some values is different than for other values. In one example of digital numbers, the highest frequency of occurrence is the value 0, the next highest frequency of occurrence is the value 1 and the other values greater than 1 (namely 2, 3, 4, 5, and so on) occur least frequently. With such order to the frequency of occurrence of values to be coded, the ordered redundancy coding of the present invention is most efficient.

Using ordered redundancy coding, the system codes the highest most frequently occurring values (0's in the usual example) using runlength coding. In the most preferable example, the runlength encoding is of two types, R and R'. The first type, R, is utilized when a runlength of consecutive zeros (0's) is followed by the next most frequently occurring value (1 in the usual case) and the other type, R', is utilized when the runlength of consecutive zeros (0's) is followed by some other value, one of the least frequently occurring values (usually greater than 1 such as 2, 3, and so on). Whenever the second type, R', of runlength coding is employed, the runlength code is typically followed by an amplitude code which explicitly encodes the actual amplitude (2, 3, . . .) of the following other value. Whenever the first type, R, of runlength coding is employed, no coding of the second value (usually 1) is required because an amplitude of 1 is implied simply by the use of the first type, R, of runlength coding.

The ordered redundancy coding of the present invention is typically utilized in a system that processes input signals, such as spatial domain image signals occurring in successive frames, to form processed signals for each frame. Any number of different processing modes are possible. The processed signals are in the form of a plurality of multivalued digital numbers, X(k), typically one number, X(k), for each frame.

In one particular embodiment, the processing modes include two replenishment modes (one with motion compensation and one without), two DPCM modes (one with motion compensation and one without) and one intraframe mode. The decision as to which mode to select is made based upon an analysis of the frame-to-frame differences (motion) between the current input signals and the previous input signals.

Typically, the system determines differences between the current input signals and the previous input signals using mean-square difference signals. These mean-square signals are processed and compared with one or more thresholds for determining one of several modes of operation. After processing in some mode, the processed signals are in the form of digital numbers and these digital numbers are coded, using ordered redundancy coding, and transmitted to a receiver.

After transmission of the coded signals, the received signals are decoded and processed in reverse of the particular one of the modes by which the signals were processed in the transmitter.

In accordance with the above summary, the present invention achieves the objective of providing an improved signal processor for reducing redundancy using ordered redundancy coding.

The foregoing and other objects, features and advantages of the invention will be apparent from the following detailed description in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a block diagram of a transmitter and receiver system.

FIG. 2 depicts further details of the transmitter of the FIG. 1 system.

FIG. 3 depicts further details of the coder used in the FIG. 2 transmitter.

FIG. 4 depicts further details of the decoder used in the receiver.

DETAILED DESCRIPTION

Overall System—FIG. 1

In FIG. 1, a block diagram of a transmitter and a receiver in accordance with the present invention is shown. Digital signals to be processed are input on lines 5 to the transmitter 2. The input signals on lines 5 are processed in one of a number of different modes so as to efficiently compress the data input signals to form processed signals for transmission to a receiver. The processed signals are coded and output on lines 45 from the transmitter 2 and are transmitted to the receiver 3.

The transmitter 2 includes a forward processor 52 and a feedback (reverse) processor 51. Typically, the input signals on lines 5 represent images and are presented in the space domain as frames in accordance with well known techniques. The forward processor 52 typically processes the spatial domain input signals to form processed signals which typically are transform domain signals arranged in blocks of transform domain coefficients. The forward processor 52 processes the current input signals from the most current frame.

The reverse processor 51 typically inverse processes signals from transform domain to spatial domain. Processor 51 stores signals representing the previous frame of data and also receives the current input signals so as to enable a comparison to be made between the previous inverse processed input signals and the current input signals. When the current input signals have been transformed from the spatial domain to the transform domain, the reverse processor performs an inverse transform to convert the transform domain signals back to spatial domain signals and stores those spatial domain signals for comparison with the current input spatial domain signals.

The reverse processor 51 determines changes between the current signals and the previous signals. Typically, these differences are determined using mean-square signals, d_0 and d_b, hereinafter defined. These mean-square signals are processed and compared with

one or more thresholds for determining one of several modes of operation for the system of FIG. 1.

Any number of different modes are possible. In one particular embodiment, two replenishment modes (one with motion compensation and one without), two DPCM modes (one with motion compensation and one without) and one intraframe mode are employed. The decision as to which mode to select is made based upon an analysis of the frame-to-frame differences (motion) of the input data. After the processing by the processor 52 and the processor 51, the processed signals are input to the coder 14.

The coder 14 encodes the processed signals using statistical frequency coding. With satistical frequency coding, signals with a statistically higher frequency of occurrence are encoded with a shorter code length than signals with a statistically lower frequency of occurrence. Additionally, the coder 14 utilizes a novel ordered redundancy (OR) coding technique. In the ordered redundancy coding, the processed signals to be coded have multiple values. For example, values are typically 0, 1, 2, 3, 4, . . . , and so on. Typically, the statistical frequencies of the values to be coded have an order. Particularly, that order is based upon the probable frequency of occurrence of the different values. The highest frequency of occurrence is typically the value 0, the next most frequently occurring value is 1 and the other values greater than 1 (2, 3, 4, 5, and so on) occur least frequently. With such order to the signals to be coded, the ordered redundancy coding of the present invention is most efficient.

Using OR coding, the coder 14 of FIG. 1 codes the highest most frequently occurring values (0's in the usual example) using runlength coding. In the most preferable example, the runlength encoding is of two types, R and R'. The first type, R, is utilized when the runlength of 0's is followed by the next most frequently occurring value (1 in the usual case) and the other type, R', is employed when the runlength of 0's is followed by some other value of the least frequently occurring type (usually greater than 1 such as 2, 3, and so on). Whenever the R' type of runlength coding is employed, the runlength code is typically followed by an amplitude code which explicitly encodes the actual amplitude of the other value. Whenever the first type, R, of runlength coding is employed, no coding of the second value (usually 1) is required because an amplitude of 1 is implied simply by the use of the first type, R, of runlength coding.

After the ordered redundancy coding in coder 14, data is transferred to the transmitter buffer 15. The buffer 15 provides a feedback signal on line 25 to control the forward processor 52 data rate.

In FIG. 1, the data from line 45 is input on line 68 after transmission over some conventional transmission medium to the receiver 3. In the receiver 3, a receiver buffer 53 stores the received data. A decoder 54 decodes the received data. Thereafter, the decoded data is processed in reverse of the particular one of the modes by which the data was processed in the transmitter 2. The reconstituted data appears on output line 69.

Transmitter—FIG. 2

FIG. 2 is a block diagram of a transmitter for motion compensated combined interframe and intraframe coding system of FIG. 1. Motion compensation is incorporated into a combined interframe and intraframe coding system using the spatial pixels in the inverse loop 9. In operation, the original spatial image on input lines 5 is compared to the reconstructed spatial image on lines 6 of the previous frame on a block-by-block basis through a motion detector 7. The reconstructed spatial image is obtained from the memory 18 of the feedback DPCM loop 9.

The feedback loop 9 includes the inverse normalizer 16, inverse transformer 17, the sum unit 20, the delay (memory) 18, the prediction unit 19, and the motion detector and compensator 7. If the motion detector 7 determines that there is little difference between the blocks, a "replenishment mode" is selected. On the other hand, if enough difference is detected, the block in the current frame is compared to the neighborhood of the corresponding reconstructed block in the previous frame to find the best match of the block. For the purpose of increasing the system performance a sub-pixel match is employed. If the difference between the current block and its best matched block does not result in a reasonable improvement over the difference between the current block and its original counterpart, a motion compensation is not justified. In this case, a "DPCM mode" with variable predictions is selected to handle the block difference. On the other hand, if the difference between the current block and its best matched block is reasonably smaller than the difference between the current block and its original counterpart, a motion compensation is initiated. In this case, the difference between the current block and its best matched block is screened to determine if the block belongs to a "motion compensated replenishment" block or a "motion compensated DPCM" block. The forward loop of the DPCM system encodes the "DPCM" or "motion compensated DPCM" data in the transform domain. Statistical frequency coding is employed to improve the efficiency. The feedback loop of the DPCM system is operated in the spatial domain with variable predictions.

Motion Detection and Compensation

The motion detection serves two purposes. It compares the block pixels in the present frame to the neighborhood pixels of the corresponding block in the previous frame to find the sub-pixel displacement of the block that gives the best match. It also tracks the displacement vectors and the degree of differences during the matching process for a subsequent modification of the DPCM frame memory and controlling of the predictor parameters in the feedback DPCM loop. Three basic types of modes (replenishment modes, intraframe mode, and DPCM modes) are determined from the motion detection. A decision process among the modes is employed. The decision process relies in part on a determination as to whether motion-compensation or non-motion-compensation is to be employed. Motion compensation is determined using the mean-square difference, d_0, and the mean square error, d_b.

The mean-square difference, d_0, is formed as follows:

$$d_0 = (1/N^2) \sum_{j=0}^{N-1} \sum_{k=0}^{N-1} [f(j,k) - \bar{f}(j,k)]^2 \qquad \text{Eq. (1)}$$

where f(j,k) are spatial pixels (on lines 5 of FIG. 2) of the current frame and $\bar{f}(j,k)$ are the corresponding pixels (on line 6 of FIG. 2) of the reconstructed previous frame. N is the transform block size.

The mean-square error, d_b, is formed as follows:

$$d_b = (1/N^2) \sum_{j=0}^{N-1} \sum_{k=0}^{N-1} [f(j,k) - \bar{f}(j + \Delta j, k + \Delta k)]^2 \quad \text{Eq. (2)}$$

where f(j,k) are the block pixels in the present frame and f(j+Δj,k+Δk) are the best matched pixels in the previously reconstructed frame where Δj,Δk are the displacement (vector) for the best match.

Replenishment Modes

The replenishment modes are either motion-compensated or non-motion-compensated. The decision process selects compensation or non-compensation based upon motion detection. The motion detection unit 7 of FIG. 2 determines the difference between the incoming spatial pixels of a block and the reconstructed spatial pixels of the corresponding block in the previous frame. If the motion detection process determines that there is little frame-to-frame difference between corresponding blocks, a non-motion-compensated replenishment mode is selected and a code word is sent on line 21 from unit 7 of FIG. 2 to the encoder 14 to identify the mode.

If the motion detection process determines that the frame-to-frame block difference is great enough then, under some circumstances, a motion-compensated replenishment mode is selected. The detection process typically uses the mean-square difference, d_0, and compares it to a predetermined non-motion-compensated replenishment threshold, T_R. This process is written as follows:

if $(d_0 - d_b) < T_M$ and $d_0 < T_R$, select non-motion-compensated replenishment mode.

The detection process compares the mean square error, d_b, with a predetermined motion-compensated replenishment threshold, $T_{D/R}$, as follows:

if $(d_0 - d_b) > T_M$ and $d_b < T_{D/R}$, select motion-compensated replenishment mode.

The identification code words for the replenishment modes are typically Huffman coded. Typically, a one-bit code (0), on line 21 of FIG. 2 is used if the non-motion-compensated replenishment mode appears most frequently statistically. Once this code word is identified at the receiver, the reconstructed block pixels in the previous frame are repeated to form the present block in the receiver.

For the motion compensated replenishment block, typically a four-bit code (1111) is used, along with the displacement vector representing the best match, and appears on line 67 in FIG. 2. At the receiver, the vector uses the compensated block pixels from the reconstructed previous frame to form the presently reconstructed block.

DPCM Modes

The DPCM modes are either non-motion-compensated or motion-compensated. Selection of the compensation or non-compensation DPCM modes is dependant in part on motion detection. The motion detection searches for the best matched block pixels from the reconstructed previous frame. The difference, d_b, between the present block pixels and the best matched block pixels is then computed. If this difference is smaller than the motion threshold, T_M, no motion compensation is justified due to the necessity of sending the displacement vector as coding overhead. In this case, the difference, d_0, is compared to a DPCM threshold, $T_{D/I}$, to determine if the block belongs to a DPCM mode. The decision process is given as follows:

if $(d_0 - d_b) < T_M$ and $d_0 < T_{D/I}$, select non-motion-compensated DPCM mode.

If a non-motion-compensated DPCM mode is selected, the predictor in the feedback loop is enabled and the difference is sent to the discrete cosine transformer for subsequent encoding. Again, the mode identification is Huffman coded. Typically, a two-bit code (10) used for the non-motion-compensated DPCM mode and appears on line 66 in FIG. 2.

At the receiver, the DPCM data are inversely transformed and added onto the block pixels from the reconstructed previous frame to form the present block pixels.

For the motion-compensated DPCM mode, the difference, d_b, between the current block pixels and the best matched block pixels is compared to a predetermined motion-compensated replenishment threshold, $T_{D/R}$. If d_b is larger than the threshold, a motion-compensated DPCM mode is selected to handle the pixel differences.

The decision processs is given as follows:

If $(d_0 - d_b) > T_M$ and $d_b > T_{D/R}$, select motion-compensated DPCM mode.

For the motion compensated DPCM blocks, typically a three-bit code (110) is used together with the displacement vector representing the best match of the block along with the motion compensated DPCM data (transform coefficient differences between the present block and the best matched block from the reconstructed previous frame). The mode ID and vector appear on line 65 in FIG. 2. At the receiver, these DPCM data are inverse transformed and added onto the compensated block pixels from the reconstructed previous frame to form the present block pixels.

Intraframe Mode

The intraframe mode is selected when neither the motion-compensated mode nor the DPCM mode is justified. The difference, d_0, between the current block pixels and the reconstructed previous block pixels is compared with the predetermined DPCM threshold, $T_{D/I}$. The decision process is as follows:

If $(d_0 - d_b) < T_M$ and $d_0 > T_{D/I}$, select intraframe mode.

If the intraframe mode is selected, the predictor is disabled and the current block pixels are sent to the transformer with unit 11 of FIG. 2. Typically, a four-bit code (1110) appearing on line 66 in FIG. 2 is used to identify the "intraframe mode". The intraframe data in the receiver are inversely transformed to form the present block pixels.

Compensation Range and Resolution

The performance of the motion compensated system is dependent upon the range and resolution of the matching process. The larger the range and the finer the resolution, the better the system performs. However, due to the necessity of encoding the vector information as system overhead, the range and resolution of the searching process is somewhat limited.

Searching Algorithm

The search for the best matched position is a very time consuming process. As one example, a simple binary search algorithm for a maximum range of 1.75 can be employed. Using such an algorithm, the nine whole-pixel positions centered around the position of the present block are first examined to find the best match. Next, the eight half-pixel neighborhood positions centered around the best matched whole-pixel position are examined. The process continues until the best matched quarter-pixel position is located. The horizontal and

vertical addresses of this location are then recorded as a vector and encoded accordingly. The number of steps required for a binary search is many times lower than that of a brute force search.

Subpixel translation is done by performing bilinear interpolation taking weighted averages of the four nearest values at integral pixel positions surrounding the subpixel location. The weighting factors that are used are linear functions of the horizontal and vertical distance of the fractional displacement from the integral pixel positions. As an example, a displacement of 1.25 horizontally, and 0.75 vertically is performed as follows:

$$f(j+1.25,k-0.75)=w_1f(j+1,k)+w_2f(j+1,k-1)+w_3f(j+2,k)+w_4f(j+2,k-1) \quad \text{Eq. (3)}$$

where $w_1=(0.75)\ (0.25)$, $w_2=(0.75)\ (0.75)$, $w_3=(0.25)\ (0.25)$, and $w_4=(0.25)\ (0.75)$

DPCM Loop

Referring to FIG. 2, the Differential Pulse Code Modulated (DPCM) loop consists of a cosine transform unit **11**, a normalization unit **12**, a quantization unit **13**, an inverse normalization unit **16**, an inverse transform unit **17**, a delay memory **18**, and a prediction unit **19**. In operation, an input pixel block on lines **5** from the present frame is first subtracted in subtractor **10** by its estimation from the previous frame on line **23** on a pixel-by-pixel basis to generate block differences. These differences are then cosine transformed in transform unit **11** to form the coefficient differences on lines **24**. The coefficient differences are next scaled in normalizer unit **12** according to a feedback parameter on lines **25** from the output rate buffer **15**. The scaled coefficient difference on lines **26** are then quantized in unit **13** and fed into both the coder unit **14** and the inverse DPCM loop **9**. In the inverse DPCM loop **9**, the quantized and scaled data are inversely normalized in unit **16** and inversely transformed in unit **17**, to form the quantized coefficient differences on lines **27**. These differences are then added in adder **20** to the motion compensated estimation on lines **3** to form the reconstructed pixel block in the frame memory **18**. After a single-frame delay, in memory **18**, the motion detector **7** uses the motion compensated block from the memory **18**, multiplies it by a prediction weighting factor, and is ready for the next frame of operation. At the receiver, the received data follows the inverse DPCM loop to reconstruct the spatial pixels in the output block.

Cosine Transform

The coefficient differences between the input pixels from the present frame on lines **5** and the estimations from the previously reconstructed frame on lines **3** are formed by the difference circuit **10** on lines **23** and are expressed as follows:

$$e_n(j,k)=f_n(j,k)-p(j,k)\bar{f}_{N-1}(j+\Delta j,k+\Delta k) \quad \text{Eq. (4)}$$

where Δj and Δk represent the vector values for the best match determined by the motion detector and where $p(j,k)$ represents the estimation. These differences within a $N\times N$ block are cosine transformed in transformer **11** to form the coefficient differences on lines **24**. The cosine transform is defined as follows:

$$E_n(u,v) = 4[C(u)C(v)]/N^2 \sum_{j=0}^{N-1}\sum_{k=0}^{N-1} e_n(j,k) \quad \text{Eq. (5)}$$

-continued

$$\cos[(2j+1)u\pi/2N]\cos[(2k+1)v\pi/2N]$$
$$\text{for } u,v = 0, 1, \ldots, N-1$$
$$C(w) = 1/(2^{\frac{1}{2}}) \quad \text{for } w = 0$$
$$= 1 \quad \text{for } w = 1, 2, \ldots, N-1$$

where w=u or v

where (j,k) and (u,v) represent indices in the horizontal and vertical directions for the pixel difference and coefficient difference blocks, respectively, and where C(w) represents C(u) or C(v). The cosine transform restructures the spatial domain data into the coefficient domain such that it will be beneficial to the subsequent coding and redundancy removal processes.

Normalization

The coefficient differences, $E_n(u,v)$, are scaled according to a feedback normalization factor, D, on lines **25**, from the output rate buffer **15** according to the relation,

$$I_n(u,v)=E_n(u,v)/D \quad \text{Eq. (6)}$$

The scaling process adjusts the range of the coefficient differences such that a desired number of code bits can be used during the coding process.

Quantization

The quantization process in unit **13** is any conventional linear or non-linear quantization. The quantization process will set some of the differences to zeros and leave a limited number of significant other differences to be coded. The quantized coefficient differences on lines **28** are represented as follows:

$$\bar{I}_n(u,v)=Q[I_n(u,v)] \quad \text{Eq. (7)}$$

where Q[ ] is a quantization function.

It should be noted that a lower bound is determined for the normalization factor in order to introduce meaningful coefficient differences to the coder. Generally speaking, setting the minimum value of D to one is sufficient for a low rate compression applications involving transform blocks of 16 by 16 pixels. In this case the worst mean square quantization error is less than 0.083. This mean square error corresponds to a peak signal-to-quantization-noise ratio of 40.86 db which is relatively insignificant for low rate applications.

Inverse Normalization

The process of inverse normalization in unit **16** produces the quantized coefficient differences on lines **29** in the inverse DPCM loop **9**. This process is represented as follows:

$$\bar{E}_n(u,v)=\bar{I}_n(u,v)D \quad \text{Eq. (8)}$$

Inverse Cosine Transform

The inverse cosine transform process in unit **17** in the inverse DPCM loop **9** converts the quantized coefficient differences on lines **29** back to the spatial domain pixel differences on lines **27**. This process is defined as follows:

$$\bar{e}_n(j,k) = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} C(u)C(v)\bar{E}_n(u,v) \quad \text{Eq. (9)}$$

$$\cos[(2j+1)u\pi]/2N \quad \cos[(2k+1)v\pi]/2N$$
$$\text{for } j, k = 0, 1, \ldots, N-1.$$

Frame Memory

The frame memory 18 contains the reconstructed input pixels in the inverse DPCM loop. The quantized pixel differences from the inverse cosine transformer on lines 27 and the motion compensated estimations from the previously reconstructed frame on lines 3 are added together in adder 20 to form the reconstructed pixels, $\bar{f}_n(j,k)$, which replace the block pixels in the memory 18. This process is represented as follows:

$$\bar{f}_n(j,k)=\bar{e}_n(j,k)+\rho(j,k)\bar{f}_{n-1}(j+\Delta j,k+\Delta k) \quad \text{Eq. (10)}$$

Prediction

The prediction process in unit 19 finds an estimation of a datum from its surrounding data. By way of example for a simple predictor that uses the previous frame as a base for the estimation, the estimated value is termed as the correlation coefficient, $\rho(j,k)$, given as follows:

$$\rho(j,k)=E[e_n(j,k)e_{n-1}(j+\Delta j,k+\Delta k)]/\sigma^2(j,k) \quad \text{Eq. (11)}$$

where E represents expected value and $\sigma^2(j,k)$ represents the variance of $e_n(j,k)$. The correlation coefficient, termed as leak factor, ranges from 0 to 1 depending on the frame-to-frame pixel differences. The value is very close to 1 for a limited motion sequence. However, during a scene cut or a rapid zooming sequence, the value is way below the value of 1. Because different leak factors have to be identified in the encoding of the DPCM process, it represents a significant overhead for the low rate system if too many values are to be identified. In one embodiment, only two leak factor values are used for the five-mode motion detection system: 1 for the non-motion-compensated DPCM and motion compensated DPCM modes and 0 for the intraframe mode.

Coding

In order to minimize overhead code bits, in one typical example the encoding process in unit 14 for the FIG. 2 system is performed on a frame by frame bases. The coded bit stream includes sync, header, scaling factor (NF), and variable-length data as follows:

TABLE 1

			variable
SYNC	HEADER	NF	DATA

In the header, at least one bit is reserved for the identification of full motion and graphic operations. The data portion includes the block-to-block mode identifiers, the vector values, DPCM and intraframe data. The bit allocations are dependent upon each individual block which is illustrated in TABLE 2.

TABLE 2

1		
MODE		
Replenishment Block		
4	8	
MODE	VECTOR	
Replenishment of Motion Compensated Block		
2	variable	
MODE	DPCM	EOB
DPCM of Non-motion Compensated Block		
4	variable	
MODE	INTRAFRAME	EOB
Intraframe of Non-motion Compensated Block		

TABLE 2-continued

3	8	variable	
MODE	VECTOR	DPCM	EOB
DPCM of Motion Compensated Block			

DPCM Encoding

The Scene Adaptive Coding (SAC) is very efficient in terms of coding the intraframe transform coefficients. When this scheme is applied to a coding system involving intraframe, interframe and motion compensation, the coding efficiency is somewhat reduced due to the structure of coefficient differences or motion compensated coefficient differences caused by the additional removal of redundancies. One observation that can be made in the motion compensated coefficient differences (non-zero after normalization and quantization) and, to a certain degree, the interframe coefficient differences (non-zero differences) is that most of these differences are sparsely distributed with an overwhelming majority of them having an absolute value of one. Also, within these differences of ones, a significant portion of them are isolated (surrounded by zero-valued coefficients) along the path of a scanning. It is wasteful to use one amplitude code word to code each of these isolated ones in addition to using one runlength code word to identify their address (Runlength alone should be enough).

Ordered Redundancy Coding

A new Ordered Redundancy (OR) coding algorithm is specifically designed to code multi-valued digital numbers where the statistical frequency of occurrence of some values in the series of values forming the digital number is greater than the statistical frequency of occurrence for other values in the series of values forming the digital number. The values forming the digital numbers are generally the integers 0, 1, 2, 3, . . . and so on.

In general, a K-valued digital number, X(k), is formed by a series of K values, x(k), as follows:

$$X(k)=x(1), x(2), x(3), \ldots x(k), \ldots, x(K)$$

where $1 \leqq k \leqq K$. Each value, x(k), has some value, V_j, from the set of J values,

$$V_1, V_2, V_3, \ldots, V_j, \ldots V_J$$

where $1 \leqq j \leqq J$.

The occurrence of i consecutive values, V_j, within the series X(k) is the runlength of such values denoted by V_j^i.

In a first example with k=1, . . . , 14, if the digital number $X_1(k)$=01000000100021, $V_0=0$, $V_1=1$ and $V_2=2$ then $X_1(k)=V_0^1, V_1^1, V_0^6, V_1^1, V_0^3, V_2^1, V_1^1$. In the series values forming $X_1(k)$, the first value $V_0=0$ occurs most frequently, the second value $V_1=1$ occurs next most frequently, and the other value $V_2=2$ occurs least frequently.

In a second example with k=1, . . . , 14, if the digital number $X_2(k)$=02111110001130, and $V_0=1$, $V_1=0$, $V_2=2$, and $V_3=3$; then $X_2(k)=V_1^1, V_2^1, V_0^5, V_1^3, V_0^2, V_3^1, V_1^1$. In the series of values forming $X_2(k)$, the first value, $V_0=1$, occurs most frequently, the seond value $V_1=0$ occurs next most frequently, and the other values, $V_2=2$ and $V_3=3$, occur next most frequently.

Digital numbers formed with such frequencies of occurrence of values such as for $X_1(k)$ and $X_2(k)$ above, are defined as having ordered redundancy. In the typi-

cal example described for $X_1(k)$, 0's are most redundant, 1's are next most redundant, and so on. The frequency of occurrence order of values 0, 1, 2, . . . and so on described is merely one typical example. Any frequency of occurrence order is possible, for example, the 2's may occur more frequently than 1's and 0's may occur more frequently than 2's.

Digital numbers, X(k), will often have ordered redundancy of the values, V_j, forming the number. Ordered redundancy means that the frequency of occurrence of some of the values, V_j, formng the number (or groups of such values) is greater than that for other values (or other groups of such values) forming the number and that such frequencies of occurrence are predictable for a number of digital numbers, X(k).

When such ordered redundancy occurs, the ordered redundancy coding of the present invention is useful in making the coding more efficient. In the present invention, the presence of a first value (or a first set of values) is used to imply the existence of a second value (or a second set of values) thereby eliminating the need to code the second value (or second set of values).

By way of example, the coding of the digital number $X_1(k)$ above is achieved as follows. Assume that when the first value, V_0, is followed by the second value, V_1, that the second value is implied and such code is denoted C_{01}^i where i represents the number of consecutive first values V_0 preceding the implied second value, V_1. Assume that when the first value V_0, is not followed by the second value, V_1, such code is denoted $C_{0\bar{1}}^i$. Assume that any other value is amplitude coded with $A_2=2$ and $A_3=3$. With such a notation, $X_1(k)=C_{01}^1$, C_{01}^6, $C_{0\bar{1}}^3$, A_3, C_{01}^0.

By way of the second example, $X_2(k)$ above, the first value, V_0-1 implies the second value, $V_1=0$ such that $X_2(k)=C_{01}^0$, $C_{0\bar{1}}^3$, A_2, C_{01}^5, C_{01}^0, C_{01}^0, C_{01}^0, $C_{0\bar{1}}^2$, A_3, C_{10}^0.

In order to code $X_1(k)=C_{01}^1$, C_{01}^6, $C_{0\bar{1}}^3$, A_3, C_{01}^0, each of the values C_{01}^1, C_{01}^6 and so forth are represented by a unique statistical code (typically a binary code) from a runlength table such that the statistically more frequently occurring values have shorter code lengths and the statistically less frequently occurring values have longer code lengths.

A series of values in digital numbers having a large percentage of zeros (0's) followed by ones (1's) is termed "One's Redundancy". One's Redundancy Coding is one example of Ordered Redundancy (OR) coding. The OR coding procedures for One's Redundancy appear in TABLE 3 and are based upon 16×16 transform blocks of values where each such block gives rise to a digital number, X(k), having 256 values. Of course, any size blocks (N×M) of digital values can be selected. Also, the digital values can be in block form representing transform coefficients or can be multi-valued digital signals, X(k), of any form.

In order to identify the beginning or end of the values forming a number, X(k), a special "End of Block" signal, EOB, is utilized. When a plurality of numbers $X_1(k)$, $X_2(k)$, $X_3(k)$, . . . and so on are to be coded and transmitted, the EOB code is inserted between the numbers, usually once after each number.

The TABLE 3 example is premised upon digital signals having first values $V_1=0$, second values $V_2=1$, and a set of other values, $V_{\bar{2}}$, greater than 1 (2, 3, 4, . . .). Also, TABLE 3 has a runlength table partitioned into first and second parts, a first part, R (or C_{01}), and a second part, R' (or $C_{0\bar{1}}$). The first part, R, implies that a runlength of 0's is followed by a 1. The second part, R', implies that a runlength of 0's is followed by another value greater than 1 (2, 3, 4, . . .). The TABLE 3 formulation is for one preferred embodiment of the ordered redundancy coding. Many variations, some hereinafter described, are possible.

TABLE 3

1. From the magnitude (without sign) of quantized coefficient difference, form the following sets of histograms
   a. Runlength of consecutive zero-value coefficient differences (including runlength of zero length) with absolute amplitude value of one at the end of the runlength.
   b. Runlength of consecutive zero-valued coefficient differences (including runlength of zero length) with absolute amplitude value of greater than one at the end of the runlength.
   c. Occurrence of end of blocks (EOB, all 0's)
2. Get runlength Huffman code table from the histogram of 1 above. The entries of this table can be represented as R_0, R_1, R_2, . . . , R_{255}, R'_0, R'_1, R'_2, . . . , R'_{255}, EOB.
3. From case b of 1, get the histogram of the amplitudes (with values greater than one) at the end of the runlength.
4. Get amplitude Huffman code table from the histogram of 3 above. The entries of this table can be represented as A_2, A_3, A_4, . . . , A_{510}.
5. Encode the coefficient differences along the zig-zag path from the Huffman tables generated from 2 and 4 in the following fashion.
   a. Coefficient differences of one at the end of the consecutive zeros—encode with R+SIGN, n=1, 2, 3, . . . , 255.
   b. Coefficient differences of greater than one at the end of consecutive zeros—encode with $R'+A_m+$SIGN, n=1, 2, 3, . . . , 255 and m=2, 3, 4, . . . , 510.
6. Encode with EOB at the end of each block.

As can be seen from TABLE 3, two Huffman tables or equivalent statistical coding tables are specified in the "One's Redundancy" (OR) coding. The runlength table (including EOB) consists of two parts, R and R', with a total of 513 entries (256 each for the first part R and the second part R' and 1 for EOB). The amplitude table consists of 509 entries (amplitude values of 2 to 510). In a practical implementation, these two tables can be shortened with little performance degradation.

Specific examples of the two tables specified in accordance with TABLE 3 appear as the following TABLES 6 and 7. TABLE 6 is a runlength table of the two part example (R and R' or R_1 and R_2) where R implies a runlength of 0's followed by a 1. TABLES 6 and 7 are derived based upon the hardware constraints (which are intended to be representative of a practical system, but are not intended to be limiting) of the following TABLE 4:

TABLE 4

1. Every code word must belong to part of a complete "tree".
2. The longest code word (including runlength escape, runlength code and sign, or amplitude escape and amplitude code) must not exceed 16 bits in length.
3. The maximum number of entries for each runlength or amplitude table must not exceed 32.

TABLE 5 gives four comparative examples for coding digital numbers using Scene Adaptive Coding (SAC) and One's Redundancy (OR) coding. The One's Rendundancy coding examples utilize TABLES 6 and 7 and the Scene Adaptive Coding examples utilize TABLES 8 and 9. As can be seen from TABLE 5, the OR coding is considerably shorter than the SAC coding and hence OR coding is more efficient.

TABLE 5

COMPARISON OF "OR" AND "SAC" CODING		
1.	CO	0000000000000000001 EOB
	SAC	$RLP+R_{19}+A_1+S+EOB$
		01/1110111/11/0/100001
	OR	$R_{19}+S+EOB$
		0001000/0/0010
2.	CO	001-1000001000-1 EOB
	SAC	$RLP+R_2+A_1+S+A_1+\bar{S}+RLP+R_5+A_1+S+RLP+R_3+A_1+\bar{S}+EOB$
		01/1111/11/0/11/1/01/11010/11/0/01/1011/11/1/100001
	OR	$R_2+S+R_0+\bar{S}+R_5+S+R_3+\bar{S}+EOB$
		1110/0/10/1/00011/0/0000/1/0010
3.	CO	20000000-1 EOB
	SAC	$A_2+S+RLP+R_7+A_1+\bar{S}+EOB$
		101/0/01/110011/11/1/100001
	OR	$R_0'+A_2+S+R_7+\bar{S}+EOB$
		110/1/0/011110/1/0010
4.	CO	1001-200001 EOB
	SAC	$A_1+S+R_2+A_1+S+A_2+\bar{S}+R_4+A_1+S+EOB$
		11/0/1111/11/0/101/1/11100/11/0/10001
	OR	$R_0+S+R_2+S+R_0'+A_2+\bar{S}+R_4+S+EOB$
		10/0/1110/0/11011/01101/0/0010

where,

R=runlength, A=amplitude, S=positive sign, $\bar{S}$=negative sign, RLP=Run Length Prefix (01), EOP=End Of Block, CO=digital number to be coded

TABLE 6

RUN LENGTH CODE TABLE FOR THE "ONE'S REDUNDANCY" CODING

RUN LENGTH CODES FOR DPCM MODE

T	L	FREQ	# of BITS	CODE	OCTAL EQUIV
R	0	26644.	2	10	2
R'	0	15621.	3	110	6
R	1	12324.	3	010	2
R	2	7148.	4	1110	16
R	3	4610.	4	0000	0
R	4	3384.	5	01101	15
R'	1	3143.	5	01100	14
R	5	2577.	5	00011	3
R	6	1967.	6	111100	74
R	7	1764.	6	011110	36
R	8	1452.	6	001111	17
R	9	1327.	6	001101	15
R	10	1089.	6	000101	5
R'	2	1013.	7	1111011	173
R	11	994.	7	1111010	172
R	12	884.	7	0111011	73
R	13	876.	7	0111010	72
R	14	861.	7	0011100	71
R	15	687.	7	0011100	34
R	16	673.	7	0011001	31
R	17	602.	7	0011000	30
R	18	550.	7	0001001	11
R	19	496.	7	0001000	10
R	20	485.	8	01111101	175
R	21	455.	8	01111100	174
R	22	413.	8	01110001	161
R'	3	402.	8	01110000	160
R	23	370.	8	00111011	73
R	24	345.	8	00111010	72
R	ESC	4599.	5	11111	37
R'	ESC	982.	7	0111111	77

TABLE 6-continued

RUN LENGTH CODE TABLE FOR THE "ONE'S REDUNDANCY" CODING

RUN LENGTH CODES FOR DPCM MODE

T	L	FREQ	# of BITS	CODE	OCTAL EQUIV
EOB		5047.	4	0010	2

where,

R ESC=code used whenever R-type value not in table

R' ESC=code used when R'-type value not in table.

TABLE 7

AMPLITUDE CODE TABLE FOR THE "ONE'S REDUNDANCY" CODING

AMPLITUDE CODES FOR DPCM MODE

	A	FREQ	# of BITS	CODE	OCTAL EQUIV
A	2	11076.	1	1	1
A	3	3846.	2	00	0
A	4	1751.	4	0110	6
A	5	982.	5	01111	17
A	6	663.	5	01010	12
A	7	435.	6	01100	34
A	8	347.	6	010011	23
A	9	277.	6	010001	21
A	10	173.	7	0101100	54
A	11	178.	7	0101101	55
A	12	137.	7	0100100	44
A	13	113.	8	01110101	165
A	14	116.	8	01110110	166
A	15	79.	8	01001010	112
A	16	68.	8	01000011	103
A	17	67.	8	01000010	102
A	18	58.	9	011101110	356
A	19	49.	9	011101000	350
A	20	50.	9	011101001	351
A	21	30.	10	0111011111	737
A	22	32.	9	010000010	202
A	23	33.	9	010000011	203
A	24	20.	10	0100101100	454
A	25	31.	9	010000001	201
A	26	22.	10	0100101101	455
A	27	30.	9	010000000	200
A	28	23.	10	0100101110	456
A	29	14.	11	01001011111	1137
A	30	14.	11	01110111100	1674
A	31	10.	11	01001011110	1136
A	32	14.	11	01110111101	1675
A	ESC	423.	6	010111	27

where,

ESC=code used when amplitude value not in table.

TABLE 8

RUN-LENGTH CODES FOR "SCENE ADAPTIVE CODING"

VALUE	LENGTH	HUFFMAN CODE
1	1	0
2	4	1111
3	4	1011
4	5	11100
5	5	11010
6	5	10000
7	6	110011
8	6	110010
9	6	110001
10	6	110000
11	6	101011
12	6	101001
13	6	101000
14	6	100111
15	6	100110
16	6	100101
17	6	100100
18	6	100010

TABLE 8-continued

RUN-LENGTH CODES FOR "SCENE ADAPTIVE CODING"		
VALUE	LENGTH	HUFFMAN CODE
19	7	1110111
20	7	1110110
21	7	1101111
22	7	1101110
23	7	1101101
24	7	1101100
25	7	1010101
26	7	1000111
27	7	1000110
28	8	10101000
29	9	101010011
30	9	101010010
RL-ESC	6	111010

TABLE 9

AMPLITUDE CODES FOR SCENE ADAPTIVE CODING		
VALUE	LENGTH	HUFFMAN CODE
1	2	11
2	3	101
3	3	000
4	4	0011
5	5	10001
6	5	00100
7	6	100101
8	6	100000
9	7	1001110
10	7	1001100
11	7	0010111
12	8	10011111
13	8	10011011
14	8	10010011
15	8	10010001
16	8	00101101
17	9	100111101
18	9	100110101
19	9	100110100
20	9	100100100
21	9	100100000
22	9	001011001
23	9	001011000
24	10	1001111001
25	10	1001111000
26	10	1001001011
27	10	1001001010
28	10	1001000011
29	10	1001000010
AMP-ESC	6	001010
EOB	6	100001
RL-PREFIX	2	01

Ordered Redundancy Variations

Additional variations are possible, for example, three or more parts or their equivalent may be used in the runlength table. A typical example with three parts (R, R' and R") is as follows. Runlengths of consecutive first values ($V_1=0$) are runlength encoded with three different parts (R_1, R_2, or R_3) depending upon the value following the runlength of 0's. If the following value is a second value (such as $V_2=1$), then R_1 is selected for encoding the runlength of the first value (0's in this case). If the following value is a third value (such as $V_3=2$), then R_2 is selected for encoding the runlength of the first value (0's in this case). If the following value is another value (greater than 2 such as 3, 4, 5, . . .), then R_3 is selected for encoding the runlength of the first value (0's in this case). If R_3 is selected, then R_3 is followed by an amplitude code to specify the exact value (3, 4, 5, . . .) following the runlength of first values (0's).

The runlength table utilized with ordered redundancy coding can be of two parts (R and R'), three parts (R_1, R_2, and R_3), or more generally of "n" parts (R_1, R_2, . . . , R_n), where n is equal to or greater than 2.

The TABLES 6 and 7 were formed based upon the assumption that a separate sign bit, S or $\bar{S}$, not in the tables is to be used to indicate the sign of each value coded in the manner indicated in TABLE 5. Alternatively, the sign information can be encoded into TABLE 6 or TABLE 7. For example, a table like TABLE 6 can be used to represent runlengths of 0's that are followed both by positive and by negative non-zero numbers. Such a table would be greater in length than TABLE 6 (expanded essentially to double the length) to provide entries for runlengths of 0's followed by both negative and positive non-zero numbers. Of course, such a table would be ordered in accordance with the statistical frequency of both positive and negative numbers.

The two tables, TABLES 6 and 7, were formed based upon the assumption that the values to be coded were categorized into three basic groups or values, namely a first value, V_1, a second value, V_2, and all other values. In the particular example of coding, the first value V_1 is 0, the second value V_2 is 1, and the third value is one within the set of all values greater than 1. It often occurs that in a block of values to be coded, the value 0 (the first value) occurs statistically most frequently, the value 1 (the second value) occurs statistically second most frequently, and the other values (the third values) the least frequently.

With such a distribution having ordered redundancy, the coding of the second value (1's in this case) is avoided because the first value (0's in this case) is runlength coded in two parts, one part that implies that the number following the runlength of 0's is the second value (1 in this case) and the other part that indicates that the number following the runlength of 0's is within the set of third values (values greater than 1 in this case).

Alternative formulations are possible. For example, rather than categorizing the values to be coded into three groups as done in connection with TABLE 6, four or more groups are possible. For four groups, the first value (for example $V_1=0$) is coded in three parts, namely, a first part for implying a second value (for example $V_2=1$), a second part for implying a third value (for example $V_3=2$) and a third part for indicating a set of fourth values (values greater than 2).

In general, a multivalued digital number, X(k), to be coded with n-1 implied values has a first value, V_1, a second value, V_2, . . . , a j-value, V_j, a (J+1)-value, V_{j+1}, . . . , a n-value, V_n, for j ranging from 1 to n, and has other values. The digital signals are coded with n-1 implied values to form statistically coded signals such that the more frequently occurring values of the digital signals are represented by shorter code lengths and the less frequently occurring values of coded signals are represented by longer code lengths. The coding includes, for each value, V_j, for j from 1 to n, forming j^{th} runlength code values representing the number of consecutive first values followed by the j+1 value, forming additional runlength code values representing the number of consecutive first values followed by any of said other values.

While the embodiments described have used one code (such as R) based upon the existence of a runlength of a first value to imply a second value, the implied code is not limited to a single value but can be itself multivalued. For example, a runlength of 0's followed by two 1's can be implied by a code R".

While the implied coding of the second value was typically as a result of runlength coding the first value, other types of coding of the first value are included within the present invention.

As another alternative, the statistically most frequent value is not necessarily the value that is runlength encoded. Where three groups of values are employed (such as 0's, 1's and greater than 1's), the second value (1's in this case) can be runlength encoded to imply the first value (0's in this case) or to specify the third values (numbers greater than 1 in this case).

In an example where the number of values V_j, are limited, the need for amplitude coding can be eliminated. For example, if only the values $V_1=0$ and $V_2=1$ are present in the number X(k), then no amplitude coding is required since the $V_1=0$ values can be runlength coded and the values of $V_1=1$ can be implied. Similarly, for an example with only the values $V_1=0$, $V_2=1$, and $V_3=2$, the values of $V_1=0$ can be runlength coded while both $V_2=1$, and $V_3=2$, are implied using a two-part runlength table as previously described.

In an example where all of the values have the same sign, the sign coding can be eliminated.

Coder Details—FIG. 3

In FIG. 3, further details of the coder 14 of FIG. 2 are shown. In FIG. 3, each digital value, V_j, of a digital number, X(k), to be coded is input to the CO register 76. Typically, the register 76 is a 16-bit register for storing 16-bit values where the digital number, X(k), is formed of K 16-bit values, each value clocked into register 76 in sequence and one at a time. The comparator 77 compares the absolute value of each value in register 76 to determine if that absolute value is less than 1, equal to 1, or greater than 1. Comparator 78 provides a less-than-1 output signal on line 78, an equal-to-1 signal on line 79, and a greater-than-1 signal on line 80 as a function of the value in register 76. The less-than-1 signal on line 78 indicates an equal-to-0 condition. The control 81 receives the three control values on line 78, 79 and 80 from comparator 77 and controls, in a conventional manner, the coder operations.

The "zero" counter 82 counts the runlength of consecutive zeros detected by the comparator 77. Line 86 from control 81 causes counter 82 to be set to a counting mode for counting consecutive 0 values in register 76. Line 86 causes counter 82 to be reset after each runlength of zeros is counted. After being reset and with line 86 setting counter 82 to the counting mode, counter 82 will count zeros until a non-zero value is detected in register 76. If a non-zero value is detected, either a equal-to-1 signal on line 79 or a greater-than-1 signal on line 80 is enabled and detected by control 81. If an equal-to-1 signal is detected, control 81 asserts the line 87 to specify the R type of operation. The enable line 87 together with the runlength count from counter 82 addresses the runlength table 84. Runlength table 84 is typically a random access memory or a read only memory storing coded runlength values like those of TABLE 6. The 0 runlength output on line 95 from counter 82 together with the 1-bit on line 87 address the table 84 to provide a runlength coded value output on lines 93. The output from table 84 is under control of the signal on line 89 from control 81 and loads the code register 85 with the runlength coded value from the CODE column of TABLE 6. The runlength coded value implies that a runlength of zeros is followed by a 1 in the manner previously described.

After a coded value is loaded into register 85, the sign bit from register 76 is enabled to be stored in register 85 by the enable gate 91 under control of the signal 94 from the control 81.

Thereafter, the next value, V_j, of the number, X(k), is loaded into register 76. Counter 82 is cleared and a new runlength of zeros is counted until comparator 77 detects a non-zero value by asserting either an equal-to-1 signal on line 79 or a signal on line 80 signifying a greater-than-1 value in register 76. If the runlength of zeros is followed by a value greater than 1, then line 80 is asserted and control 81 causes line 87 to be not asserted, thereby signifying an R'-type of operation. The runlength value from counter 82 on line 95 together with the non-asserted signal on line 87 causes the runlength table 84 to be addressed to obtain a R' value from table 84. Line 89 causes the output from table 84 to be gated to the code register 85.

Because of a greater than 1 value in register 76, control 81 causes the line 88 to be next enabled to provide an output from the amplitude table 83. The amplitude table 83 is a random access memory or read only memroy loaded with amplitude values like those of TABLE 7. The value in register 76 addresses the amplitude table 83 to provide the appropriate amplitude value output on line 93 for storage in the code register 85. Thereafter, the control 81 causes line 94 to be enabled to cause the sign value from register 76 to be stored in the code register 85.

The FIG. 3 coder continues to process code values in register 76 until an entire block of code values (all values for a digital number, X(k)) has been processed. Control 81 includes counters and other appropriate means for counting or otherwise determining all values comprising a digital number. When a full series of values for a digital number X(k) has been processed, control 81 enables the output line 93 to provide an end of block, EOB, signal on line 93 for storage in the control register 85. Control 81 provides the CLK_1 signal for clocking each new value into register 76, provides the CLK_2 signal for incrementing the zero counter 83 and CLK_3 signal for clocking values into register 44. In a conventional manner, control 81 is controlled by a master clock signal CLK, from the transmitter of FIG. 2.

In FIG. 3, when the amplitude table 83 is addressed and produces the ESC code, the ESC detector 126 senses that no amplitude value is available in the table and signals control 81. The ESC value from table 83 is gated into the code register 85. Thereafter, control 81 enables gate 127 via line 181 to gate the value from register 76 into the code register 85. Alternatively, an additional table (not shown) can be provided for storing Huffman coded values of amplitudes not in the table 83. Such an additional Huffman table would provide compression of additional amplitude values.

In FIG. 3, when the runlength table 84 provides the R ESC or the R' ESC code value, the ESC detector 126 senses the ESC value and signals the control 81 on line 130. The ESC code value is clocked into register 85, and on the next cycle, control 81 causes alternate processing to occur. In the example described, gage 129 is enabled to enter directly the value from counter 82 into the code register 85 so that runlengths not in the runlength table 84 are directly entered after the ESC code. Alternatively, an additional runlength table with Huffman coded runlength values can be employed to provide additional compressed runlengths not in the table 84.

While FIG. 3 depicts one embodiment for implementing the coder 14 of FIG. 2, many other software and hardware implementations of the coder are, of course, possible.

Decoder Detail—FIG. 4

In FIG. 4, further details of the decoder 54 of FIG. 1 are shown. The serial-by-bit data is input on line 117 to the code register 101. The input data, as it is clocked into the register 101 by the CLK_4 signal, is continuously detected by the detector 102. Detector 102 senses the synchronization, header and other control information and signals the control 107 when coded data is to follow. The coded data is clocked into register 101 one bit at a time. A code value clocked into register 101 is presented in left-to-right order when viewing the CODE column of TABLE 6. With each new code value bit, the coded data from register 101 is input to the inverse runlength table 103 and to the inverse amplitude table 104. The runlength table 103 includes the data of TABLE 6 organized in an inverse order. The inverse order means that table 103 of FIG. 4 is addressed by the CODE column code values and provides as an output the type (R or R') from column T and the length from column L. The type information appears on output line 113. Line 113 is one binary value (for example 1) when the addressed value is of type R and is another binary value (for example 0) when the type is R'.

The R/R' information on line 113 is connected to the control 107. The L information from table 103 is input on line 119 to the runlength counter 105. Typically, the L information is a binary count and runlength counter 105 is parallel loaded with the binary count under control of line 114 from control 107.

If an R ESC or an R' ESC value is detected by detector 102, control 107 is signaled that no valid runlength will be derived from table 103. When control 107 senses that the ESC code has appeared in register 101, control 107 causes the content of the register 101 through gate 125 to be gated into the runlength counter 105. Thereafter, runlength counter 105 is decremented in the manner previously described.

Line 116 output from the table 103 is a validity bit indicating that a valid entry has been found in table 103. As each new code value bit is clocked into register 101, table 103 is addressed to determine if a valid entry is found. Not all input codes from register 101 will find a valid entry in table 103. All valid entries in table 103 provide a validity bit output on line 116 for signalling the control 107. When control 107 receives a valid bit from line 116, the length value for the addressed entry is stored into the runlength counter 105. Thereafter, the runlength counter 105 is decremented by the CLK_5 signal thereby counting out the runlength of zeros. Control line 118 inhibits any output from the amplitude table 104 whenever counter 105 is being decremented thereby loading zeros into the CO register 109. When the counter 105 has been counted down and the entire runlength of zeros has been loaded into register 109, control 107 has sensed the R or R' signal from line 113 and thereafter provides the following sequencing.

If line 113 indicated an R-type operation, then line 121 loads a 1 into the register 109 since R-type operations imply a 1 after a runlength of zeros. When line 121 writes a 1 into register 109, gate 108 is enabled by line 119 to load the sign bit, which will be the next bit in order clocked into register 101 into the register 109. Thereafter regiser 101 will be cleared and clocked to receive the next code bits.

If line 113 indicates an R'-type operation, then line 121 is not enabled and line 118 is enabled to read out an amplitude from amplitude table 104. Amplitude table 104 contains the information of TABLE 7 in inverse order. The inverse order indicates that table 104 is addressed by the information in the CODE column and provides an output on line 120 from the A column. Typically, the output value from the A column is a binary number representing the amplitude.

If an ESC value is called for, detector 102 signals control 107 to indicate that no valid amplitude will be obtained from table 104. When the A ESC code appears in the code register 101, the control 107 causes the next amplitude value in code register 101 to be gated directly via gate 108 to the CO register 109.

After an amplitude value is loaded into register 109 from table 104 or register 101, control 107 then signals via line 119 the loading of the sign bit from register 101 into register 109. Register 101 is then cleared to receive the next code value on line 117 from the buffer 53 of FIG. 1.

While FIG. 4 depicts one embodiment of a decoder in accordance with the present invention, many other software and hardware embodiments of the FIG. 5 decoder are possible.

Rate Buffer

The rate buffer 15 in FIG. 2 performs channel rate equalization. The buffer has a variable rate data input on lines 44 and a constant rate data output on lines 44. The differentials are monitored from frame to frame, and the status is converted into a scaling factor that is fed to the normalizer on lines 25. The buffer always forces the coder to adjust to the local coding variations, while ensuring global performance at a desired level.

Let B(n) represent the number of bits into the rate buffer for the nth frame and let S(n) represent the buffer status (difference between the read and write pointers of the FIFO) at the end of the nth frame. Then, B(n) and S(n) can be written as follows:

$$B(n) = K + N_1 + 12\,N_2 + \qquad \text{Eq. (12)}$$

$$2N_3 + \sum_{i \epsilon N_3} \sum H([\bar{I}(u,v)]_i) +$$

$$11N_4 + \sum_{i \epsilon N_4} \sum H([\bar{I}(u,v)]_i) +$$

$$4N_5 + \sum_{i \epsilon N_5} \sum H([\bar{I}(u,v)]_i)$$

$$S(n) = S(n-1) + [B(n) - N^2 R] \qquad \text{Eq. (13)}$$

where

N_1 = number of blocks in replenishment mode

N_2 = number of blocks in motion compensated replenishment mode

N_3 = number of blocks in DPCM mode

N_4 = number of blocks in motion compensated DPCM mode

N_5 = number of blocks in intraframe mode

$[\bar{I}(u,v)]_i$ = normalized and quantized coefficient differences in ith block

$H(.)$ = "One's Redundancy" coding function R = average coding rate

N = transform block size

K = sync, header, and NF

$i_\epsilon N_3$ = i belongs to N_3 DPCM block

$i_t N_4 = i$ belongs to N_4 DPCM block

$i_t N_5 = i$ belongs to N_5 DPCM block

The buffer status S(n) is used to select an instantaneous scaling factor $D^*(n)$ according to an empirically determined "scaling factor versus status" curve. This relationship is described by

$$D^*(n) = \Phi\{S(n)\} \quad \text{Eq. (14)}$$

In order to smooth out this instantaneous scaling factor such that the desired scaling factor does not fluctuate too much, a recursive filtering process is applied as follows:

$$D(n) = (1-c)D(n-1) + cD^*(n) \quad \text{Eq. (15)}$$

where c is a constant with value less than unity. The rate buffer can be guaranteed not to overflow by introducing a frame repetition mechanism. It can also be prevented from underflow by introducing fill bits.

Frame Repetition

The requirement of a frame repetition in the Motion Compensated Combined Interframe and Intraframe Coding System of FIG. 2 is well justified. Due to the usage of only one normalization factor per frame, an excessive amount of data can flow into the buffer during a scene cut or fast zooming operations. Only instantaneous shutting off of the input data like the frame repetition will prevent the rate buffer from overflowing. Also, in order to prevent the scaling factor from getting too large to introduce blocking artifacts, a frame repetition is desired.

To establish frame repetition in the rate buffer, a threshold in the rate buffer is first established. During the encoding process, if the data within the buffer exceeds this threshold at the end of the frame, frame repetition is initiated to stop the input data. The repetition process is stopped when the data within the buffer is reduced to a level lower than the threshold.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A method for processing digital signals, where the digital signals have first values, second values and other values, to reduce the amount of data utilized to represent the digital signals and to form statistically coded signals such that the more frequently occurring values of digital signals are represented by shorter code lengths and the less frequently occurring values of digital signals are represented by longer code lengths, comprising,

forming first runlength code values representing the number of consecutive first values of said digital signals followed by said second value,

forming second runlength code values representing the number of consecutive first values of said digital signals followed by one of said other values.

2. The method of claim 1 further including the step of amplitude encoding said other values.

3. The method of claim 1 further including the step of encoding said first and second runlength code values with a sign value.

4. The method of claim 1 wherein said first values have amplitude zero, said second values have absolute amplitude one, and said other values have absolute amplitudes greater than one whereby said first and second runlength codes values are formed representing the number of consecutive zeros.

5. The method of claim 1 wherein said first values have the highest frequency of occurrence in said digital signals, wherein said second values have the next highest frequency of occurrence in said digital signals, and wherein said other values have the lowest frequency of occurrence in said digital signals.

6. A method for processing input signals to reduce the amount of data utilized to represent the input signals, the steps comprising,

processing the input signals to form processed signals where the processed signals are digital numbers having first values, second values, and other values,

coding each digital number to form statistically coded signals such that the more frequently occurring values in the digital numbers are represented by shorter code lengths and the less frequently occurring values of coded signals are represented by longer code lengths, said coding including,

forming first runlength code values representing the number of consecutive first values followed by said second value in a digital number,

forming second runlength code values representing the number of consecutive first values followed by one of said other values in the digital number.

7. The method of claim 6 wherein said coding step includes the step of amplitude encoding said other values.

8. The method of claim 6 wherein said coding step includes the step of encoding said first and second runlength code values with a sign value.

9. The method of claim 6 wherein said processing step forms said first values with amplitude zero, forms said second values with absolute amplitude one, and forms said other values with absolute amplitudes greater than one.

10. The method of claim 6 wherein a table is provided storing a plurality of runlength code values representing a plurality of different numbers of consecutive first values followed by said second value, and storing a plurality of second runlength code values representing a plurality of different numbers of consecutive first values followed by one of said other values, said first runlength code values and said second runlength code values statistically organized in said table such that the statistically more frequently occurring runlength code values are represented by shorter code lengths and the less frequently occurring values are represented by longer code lengths, and wherein

said step of forming first runlength code values is performed by table lookup from said table,

said step of forming second runlength code values is performed by table lookup from said table.

11. The method of claim 6 wherein said coding step further includes the step of providing an end code to designate the end of a digital number.

12. A method for processing digital signals, where the digital signals have first values, second values and other values, where the processing reduces the amount of data utilized to represent the digital signals and where the processing forms statistically coded signals such that the more frequently occurring values of digital signals are represented by shorter code lengths and the

less frequently occurring values of digital signals are represented by longer code lengths, comprising,

forming a first code value representing a set of said first values followed by said second value,

forming a second code value representing a set of said first values followed by one or more of said other values.

13. A method for processing digital signals to reduce the amount of data utilized to represent the digital signals, the steps comprising,

processing the digital signals to form processed signals where the processed signals are multivalued digital numbers and have first values, second values, . . . , j-values, (j+1)-values, . . . , n-values for j ranging from 1 to n, and have other values,

coding said processed signals to form statistically coded signals such that the more frequently occurring values of the processed signals are represented by shorter code lengths and the less frequently occurring values of coded signals are represented by longer code lengths, said coding including,

forming j^{th} runlength code values representing the number of consecutive processed signals of said first value followed by said j+1 value, for each value of j from 1 to n,

forming additional runlength code values representing the number of consecutive processed signals of said first value followed by any of said other values.

14. The method of claim 13 wherein said coding step includes the step of amplitude encoding said other values.

15. The method of claim 13 wherein said coding step includes the step of encoding said j runlength code values with a sign value.

16. The method of claim 13 wherein said processing step with n=2 forms said first values with j=1 equal to amplitude zero, forms said second values with j=2 equal to absolute amplitude one, and forms said other values with absolute amplitudes greater than one.

17. The method of claim 13 wherein said processing step forms said first values with j=1 equal to amplitude zero, forms said second values with j=2 equal to absolute amplitude one, and forms third values with j=3 equal to absolute amplitude two, and forms other values for n=3 with absolute amplitude greater than 2.

18. The method of claim 6 wherein said processing step includes multiple modes of processing said digital signals to form said processed signals, and includes the step of selecting one of said modes based upon differences in said input signals.

19. The method of claim 6 wherein said input signals represent images and are presented in sequential frames, said processing step including multiple processing modes for processing said input signals to form said processed signals, and including the step of forming the mean-square difference, d_0, between input signals from the current frame and representations of input signals from the previous frame and includes the step of forming the mean-square error, d_b, between input signals from the present frame and the best matched representation of input signals from the previous frame, said processing step including the step of comparing the difference, d_0-d_b, with a motion threshold T_M, and selecting one of said modes based on said comparison.

20. The method of claim 19 including the step of determining when d_0-d_b is less than T_M and further including the step of selecting a non-motion-compensated replenishment mode when d_0 is less than a predetermined threshold T_R and d_0-d_b is less than T_M.

21. The method of claim 19 including the step of determining when d_0-d_b is less than T_M and further including the step of selecting a non-motion-compensated DPCM mode when d_b is less than a predetermined threshold $T_{D/I}$ and d_0-d_b is less than T_M.

22. The method of claim 19 including the step of selecting an intraframe mode when d_0 is greater than a predetermined threshold $T_{D/I}$.

23. The method of claim 19 including the step of determining when d_0-d_b is greater than T_M and further including the step of selecting a motion compensated replenishment mode when d_b is less than predetermined threshold $T_{D/R}$ and d_0-d_b is greater than T_M.

24. The method of claim 19 including the step of determining when d_0-d_b is greater than T_M and further including the step of selecting a motion compensated DPCM mode whenever d_b is greater than a predetermined threshold $T_{D/R}$ and d_0-d_b is greater than T_M.

25. An apparatus for processing digital signals, where the digital signals have first values, second values and other values, to reduce the amount of data utilized to represent the digital signals and to form statistically coded signals such that the more frequently occurring values of digital signals are represented by shorter code lengths and the less frequently occurring values of digital signals are represented by longer code lengths, comprising,

means for forming first runlength code values representing the number of consecutive first values of said digital signals followed by said second value,

means for forming second runlength code values representing the number of consecutive first values of said digital signals followed by one of said other values.

26. The apparatus of claim 25 further including means for amplitude encoding said other values.

27. The apparatus of claim 25 further including means for encoding said first and second runlength code values with a sign value.

28. The apparatus of claim 25 wherein said first values have amplitude zero, said second values have absolute amplitude one, and said other values have absolute amplitudes greater than one whereby said first and second runlength codes values are formed representing the number of consecutive zeros.

29. The apparatus of claim 25 wherein said first values have the highest frequency of occurrence in said digital signals, wherein said second values have the next highest frequency of occurrence in said digital signals, and wherein said other values have the lowest frequency of occurrence in said digital signals.

30. An apparatus for processing input signals to reduce the amount of data utilized to represent the input signals, the apparatus comprising,

means for processing the input signals to form processed signals where the processed signals are digital numbers having first values, second values, and other values,

means for coding each digital number to form statistically coded signals such that the more frequently occurring values in the digital numbers are represented by shorter code lengths and the less frequently occurring values in the digital numbers are represented by longer code lengths, said means for coding including,

means for forming first runlength code values representing the number of consecutive first values followed by said second value in a digital number,

means for forming second runlength code values representing the number of consecutive first values followed by one of said other values in the digital number.

31. The apparatus of claim 30 wherein said means for coding includes means for amplitude encoding said other values.

32. The apparatus of claim 30 wherein said means for coding includes means for encoding said first and second runlength code values with a sign value.

33. The apparatus of claim 30 wherein said means for processing forms said first values with amplitude zero, forms said second values with absolute amplitude one, and forms said other values with absolute amplitudes greater than one.

34. The apparatus of claim 30 including an addressable table storing runlength code values representing different numbers of consecutive first values followed by said second value, and storing a plurality of second runlength code values representing different numbers of said first values followed by one of said other values, said first runlength code values and said second runlength code values organized in said table such that the statistically more frequently occurring runlength code values in digital numbers are represented by shorter code lengths and the less frequently occurring values in digital numbers are represented by longer code lengths, and wherein

said means for forming first runlength code values includes means for addressing said addressable table with a runlength number representing the runlength of said first value followed by said second value in order to obtain said first runlength code value from said table, and

said means for forming second runlength code values includes means for addressing said addressable table with a runlength number representing the runlength of said first value followed by one of said other values in order to obtain said second runlength code value.

35. The apparatus of claim 30 wherein said means for coding further includes means for providing an end code to designate an end of a digital number.

36. An apparatus for processing digital signals to reduce the amount of data utilized to represent the digital signals, comprising,

means for processing the digital signals to form processed signals where the processed signals are multivalued digital numbers and have first values, second values, . . . , j-values, (j+1)-values, . . . , n-values for j ranging from 1 to n, and have other values,

means for coding said processed signals to form statistically coded signals such that the more frequently occurring values in the digital numbers are represented by shorter code lengths and the less frequently occurring values in the digital numbers are represented by longer code lengths, said means for coding including,

means for forming j^{th} runlength code values representing the number of consecutive processed signals of said first value followed by said j+1 value, for each value of j from 1 to n,

means for forming additional runlength code values representing the number of consecutive processed signals of said first value followed by any of said other values.

37. The apparatus of claim 36 wherein said digital signals represent pixels forming images in sequential frames, said means for processing includes multiple mode processing means for processing said digital signals to form said processed signals, and includes means for forming the mean-square difference, d_0, between digital signals representing pixels of the current frame and digital signals representing pixels of the previous frame and includes means for forming the mean-square error, d_b, between the digital signals representing pixels in the present frame and digital signals representing the best matched pixels of the previous frame, said means for processing further including means for comparing the difference, d_0-d_b, with a motion threshold T_M, and means for selecting one of said modes based on said comparison.

38. A method for processing digital signals, where the digital signals have first values, second values and other values, where the processing reduces the amount of data utilized to represent the digital signals and where the processing forms statistically coded signals such that the more frequently occurring values of digital signals are represented by shorter code lengths and the less frequently occurring values of digital signals are represented by longer code lengths, where

a first code value is formed representing a set of said first values followed by said second value,

a second code value is formed representing a set of said first values followed by one or more of said other values

comprising,

decoding said first code value to form a set of said first values followed by said second value,

decoding said second code value to form a set of said first values followed by one or more of said other values.

39. A method for processing digital signals to reduce the amount of data utilized to represent the digital signals, the steps comprising,

processing the digital signals to form processed signals where the processed signals are multivalued digital numbers and have first values, second values, . . . , j-values, (j+1)-values, . . . , n-values for j ranging from 1 to n, and have other values,

coding said processed signals to form statistically coded signals such that the more frequently occurring values of the processed signals are represented by shorter code lengths and the less frequently occurring values of coded signals are represented by longer code lengths, said coding including,

forming j^{th} runlength code values representing the number of consecutive processed signals of said first value followed by said j+1 value, for each value of j from 1 to n,

forming additional runlength code values representing the number of consecutive processed signals of said first value followed by any of said other values

transmitting said j^{th} runlength code values and said additional runlength code values to a receiver to form received signal including received j^{th} runlength code values and received additional runlength code values,

decoding said received signals to form decoded signals, said decoding including,

decoding said received j^{th} runlength code values to form a number of consecutive decoded signals of said first value followed by said j+1 value, for each value of j from 1 to n,

decoding said received additional runlength code values to form a number of consecutive decoded signals of said first value followed by any of said other values.

40. The method of claim 39 wherein said coding step includes the step of amplitude encoding said other values.

41. The method of claim 39 wherein said coding step includes the step of encoding said j runlength code values with a sign value.

42. An apparatus for processing input signals to reduce the amount of data utilized to represent the input signals, the apparatus comprising,

means for processing the input signals to form processed signals where the processed signals are digital numbers having first values, second values, and other values,

means for coding each digital number to form statistically coded signals such that the more frequently occurring values in the digital numbers are represented by shorter code lengths and the less frequently occurring values in the digital numbers are represented by longer code lengths, said means for coding including,

means for forming first runlength code values representing the number of consecutive first values followed by said second value in a digital number,

means for forming second runlength code values representing the number of consecutive first values followed by one of said other values in the digital number,

means for transmitting said j^{th} runlength code values and said additional runlength code values to a receiver to form received signal including received j^{th} runlength code values and received additional runlength code values,

means for decoding said received signals to form decoded signals, said means for decoding including,

means for decoding said received j^{th} runlength code values to form a number of consecutive decoded signals of said first value followed by said j+1 value, for each value of j from 1 to n,

means for decoding said received additional runlength code values to form a number of consecutive decoded signals of said first value followed by any of said other values.

43. The apparatus of claim 42 wherein said means for coding includes means for amplitude encoding said other values.

44. The apparatus of claim 42 wherein said means for coding includes means for encoding said first and second runlength code values with a sign value.

45. The apparatus of claim 42 wherein said means for processing forms said first values with amplitude zero, forms said second values with absolute amplitude one, and forms said other values with absolute amplitudes greater than one.

46. The apparatus of claim 42 including an addressable table storing runlength code values representing different numbers of consecutive first values followed by said second value, and storing a plurality of second runlength code values representing different numbers of said first values followed by one of said other values, said first runlength code values and said second runlength code values organized in said table such that the statistically more frequently occurring runlength code values in digital numbers are represented by shorter code lengths and the less frequently occurring values in digital numbers are represented by longer code lengths, and wherein

said means for forming first runlength code values includes means for addressing said addressable table with a runlength number representing the runlength of said first value followed by said second value in order to obtain said first runlength code value from said table, and

said means for forming second runlength code values includes means for addressing said addressable table with a runlength number representing the runlength of said first value followed by one of said other values in order to obtain said second runlength code value.

* * * * *

EXHIBIT 4

:s have been doing busi- area for some time and : advertised extensively, ; of actual confusion are entitled to great weight ion. Indeed, the existence il of instances of actual a significant time or a : of concurrent sales un- : marks may even lead to t no likelihood of confu- ions omitted).
⁻.2d at 1110.
that plaintiff's affidavits ıise a genuine question of s to preclude summary davits presented by SSI : that an alleged factual summary judgment pur- ust be material and genu- lavits do not meet this insufficient to show that prevail on this claim if to a jury.

ıannels Used

ıploy similar marketing : their products. Further, to the same target mar- ıarily on in-house sales- ıroduct through distribu- representatives. SSI and material to market their ıpanies sell their instru- ıysicians and hospitals. hat the marketing chan- ties are similar and such the possibility of confu- ;I and Boss products.

e of Purchaser Care and

rket their products to a ıer base — health care sible for purchasing sur- he Court finds that a : of surgical instruments to be confused by any tween SSI's trade dress ss.

Defendant in Selecting

s a mark with the intent , that fact alone may be n inference of confusing 111 (citing *Wynn Oil,* ı creating its promotion- ired the same graphics

designer that SSI employed to develop its promotional materials. Boss also now incorporates the phrases, "Fine Touch" and "The Art of Surgery" throughout its promotional literature. SSI previously used these terms in a 1990 supplemental catalog for Ultra ophthalmic instruments.

There are some similarities between Boss's trade dress and that of SSI; however, SSI has not demonstrated that the defendants chose these elements of its trade dress to cause confusion. In fact, because Boss has utilized these phrases consistently throughout its marketing materials including its catalogs and packaging, Boss has attempted to distinguish its trade dress from that of SSI.

(viii) Likelihood of Expansion of the Product Lines

Homeowner examines the circumstance in which the products are not competitive or closely related, reasoning that a " 'strong possibility' that either party will expand his business to compete with the other . . . will weigh in favor of finding that the present use is infringing." *Id.*, 931 F.2d at 1112 (citing Restatement of Torts § 731(b) & cmt. c (1938)). By extension, the Court will apply this analysis in the present case in which the products are competitive and closely related.

The Restatement of Torts explains that trade dress protection is limited to those cases in which there is a probability of confusion of prospective purchasers and states the relevant test as follows: "The issue in each case is whether the goods . . . of the actor and of the other are sufficiently related so that the alleged infringement would subject the good-will and reputation of the other's trade-mark or trade name to the hazards of the actor's business." Restatement of Torts, §730 cmt. b (1938).

SSI asserts that it is likely to expand the Ultra line. Boss has not indicated its intention to expand its product lines. Presently, SSI and Boss compete in the same market. Whether Boss will expand its product line in a way similar to SSI remains unclear. Assuming that Boss expands its product line, the Court does not find such expansion indicative of infringement because the likelihood of consumer confusion is not significant.

[3] Based on the analysis of the above factors, the Court rules that the relevant consumers are unlikely to confuse SSI's product with Boss's product. Notwithstanding the relatedness of the products, some similarities of the marks, and the similarities of the marketing channels used, these factors are outweighed by the weakness of plaintiff's mark, the high degree of purchaser care and sophistication, and the presence of the logos of both Boss and SSI on the respective elements of their trade dress. Further, plaintiff's evidence of actual confusion is not of substantial weight in this analysis and SSI has failed to demonstrate that Boss intended to cause confusion through its choice of trade dress.

IV. CONCLUSION

The Court finds that SSI has not met its burden of presenting a genuine issue of material fact with respect to the three elements required under the Lanham Act. The Court concludes that SSI's trade dress is ineligible for protection under the Lanham Act and this claim does not survive summary judgment.

In entering a judgment for defendants Phillips and Boss Instruments, the Court finds that a reasonable jury would be unable to return a verdict for the non-moving party. Because the record taken as a whole could not lead a rational trier of fact to find for the non-moving party, there is no genuine issue for trial. *Street v. J.C. Bradford & Co.*, 886 F.2d at 1478.

For the reasons set forth above, the Court grants the defendants' motion for partial summary judgment and dismisses with prejudice plaintiff's trade dress infringement claim and dismisses without prejudice the plaintiff's pendent state law claims. An Order consistent with the foregoing reasoning will be entered contemporaneously with this Memorandum.

District Court, N.D. California

International Business Machines Corp. v. Conner Peripherals Inc.

No. C 93 20591 RMW

Decided January 28, 1994

PATENTS

1. Title — Assignments (§150.03)

JUDICIAL PRACTICE AND PROCEDURE

Procedure — Parties; standing (§410.07)

Japanese corporation which was assigned patent in suit jointly with defendant, but which, pursuant to side agreement with defendant, has no right to sue any infringer, even if defendant refuses to do so, is not

indispensable party to defendant's infringement counterclaim, since plaintiff does not face substantial risk of incurring multiple or inconsistent obligations.

Particular patents — Electrical — Computer disk drives

4,933,785, Morehouse, Andrews, Blagaila, Furay, and Johnson, disk drive apparatus using dynamic loading/unloading, accused infringer's motion to dismiss for failure to join indispensable party denied.

Action by International Business Machines Corp. against Conner Peripherals Inc., for declaratory judgment of patent invalidity and non-infringement, in which defendant counterclaims for patent infringement. On motion by plaintiff to dismiss infringement counterclaim. Motion denied.

Patrick Lynch, Robert E. Willett, and Mark A. Samuels, of O'Melveny & Myers, Los Angeles, Calif.; David J. Cushing, of Sughrue, Mion, Zinn, Macpeak & Seas, Washington, D.C.; Anthony L. Clapes, White Plains, New York, for IBM Corp.

Paul H. Heller and Philip J. McCabe, of Kenyon & Kenyon, New York, New York; Martin S. Fleisler and Mark E. Miller, of Fleisler, Dubb, Meyer & Lovejoy, San Francisco, Calif.; Marla A. Stark, San Jose, Calif.; Michael A. Ladra, Peter N. Detkin, Michael Barclay, and Sandy L. Roth, of Wilson, Sonsini, Goodrich & Rosati, Palo Alto, Calif., for Conner Peripherals Inc.

Whyte, J.

Counterclaim defendant International Business Machines Corporation's ("IBM") motion to dismiss counterclaim plaintiff Conner Peripheral's ("Conner") second counterclaim was heard on January 7, 1994. The court has read the moving and responding papers and heard the oral argument of counsel. The court has also considered the stipulation filed by Alps Electric Co., Ltd. ("Alps") and the parties' comments relating thereto. For the reasons set forth in this opinion, the court denies defendant's motion.

I. BACKGROUND

On August 11, 1993, IBM filed a complaint against Conner seeking declaratory relief. IBM did not name Alps as a defendant in that complaint. In the eleventh claim for relief, IBM seeks a judicial declaration that the U.S. Patent No. 4,933,785 (the Morehouse '785 patent) is invalid and/or not infringed.

On September 27, 1993, Conner filed its answer to IBM's complaint as well as a number of counterclaims. The second counterclaim alleged infringement by IBM of the Morehouse '785 patent. Conner did not join Alps as a party. On October 5, 1993, IBM answered Conner's counterclaim. IBM did not raise failure to join an indispensable party as an affirmative defense, nor did IBM concurrently file a motion to dismiss under Rule 12(b)(7). On November 12, 1993, IBM moved to dismiss Conner's second counterclaim for failure to join Alps as an indispensable party.

On May 29, 1992 Prairietek Corporation, a debtor in a Chapter 11 case, assigned the Morehouse '785 patent and several other patents to Conner Peripherals jointly with Alps, a Japanese corporation. Another instrument, an Asset Purchase Agreement dated March 20, 1992, confers rights in the Morehouse '785 patent to Alps, Conner, and Alps Electric U.S.A.[1]

On April 2, 1992 Conner Peripherals and Alps signed a side agreement. Paragraph 6 of that agreement provides that Alps and Conner would acquire the Morehouse '785 patent as well as other patents from Prairietek "such that title to such patents shall be held by [Conner] and [Alps] as joint owners". The side agreement also provides in pertinent part:

> [I]t is agreed that Conner shall have the following exclusive rights with respect to the Patents, which it shall be entitled to exercise in its sole discretion without any duty of consultation with Alps: (i) the exclusive right to offer, negotiate and grant licenses and sublicenses . . . (ii) the exclusive right to prosecute continuations of the patents and any and all patent applications . . . (iii) the exclusive right to enforce, refrain from enforcing, compromise and settle any claim of infringement by any third party and to manage and determine the cost of such actions . . . (iv) . . . the exclusive right to receive all payments and cross licenses from any such transactions and (v) the right to assign or transfer its interests in any or all of the patents provided that the assignee shall become bound by the terms of this Section 5.

Therefore, pursuant to this agreement, Alps may not sue *anyone* for infringement of

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[1] IBM does not seek to join Alps Electric, U.S.A. as an indispensable party at this time.

the Morehouse '785 patent and cannot force Conner to sue anyone for infringement. The agreement also prohibits Alps from offering licenses or sublicenses in any interest in the patent. In addition, Alps cannot prevent Conner from offering licenses or sublicenses in any interest in the patent and Alps is not free to assign its interest in the patent without Conner's consent.

During the pendency of the instant motion, a stipulation was filed wherein Alps confirmed its agreement with Conner and specifically acknowledged that it would be bound by the outcome of the lawsuit and that it has no right to independently litigate any rights under the '785 patent against IBM or Western Digital or their customers or their licensees under the '785 patent.

IBM moves to dismiss Conner's second counterclaim pursuant to Rule 12(b)(7) and 19 of the Federal Rules of Civil Procedure because IBM contends that Alps is an indispensable party to Conner's second counterclaim. IBM argues that it cannot be assured of full and complete adjudication of its rights and liabilities with regards to the Morehouse '785 patent in Alps' absence from this litigation. IBM also states that the court cannot make any ruling as to Alps' ownership interest in the Morehouse '785 patent that would bind Alps in any subsequent litigation because Alps is not before the court. IBM cites *Blonder-Tongue Laboratories, Inc. v. University of Illinois Foundation*, 402 U.S. 313, 329 [169 USPQ 513] (1971) for the proposition that litigants may not be collaterally estopped if "[t]hey never had a chance to present their evidence and arguments on a claim." IBM, therefore, argues that it can only be assured protection against multiple litigation if the motion is granted.

Conner contends that the motion to dismiss must be denied because 1) IBM's motion to dismiss is untimely; 2) Alps is not an indispensable party since it is, in effect, a licensee of the Morehouse '785 patent who does not have standing to sue IBM for infringement of the '785 patent; and 3) Alps' stipulation should remove any concern IBM has as to the potential for a subsequent suit by Alps.

II. LEGAL STANDARDS

Fed. Rule Civ. Pro. 19 sets forth the conditions under which a person must be joined in a suit for that action to proceed. Rule 19(a) provides:

> Joinder of Persons Needed for Just Adjudication
>
> (a) Persons to Be Joined if Feasible. A person who is subject to service of process and whose joinder will not deprive the court of jurisdiction over the subject matter of the action shall be joined as a party in the action if (1) in his absence complete relief cannot be accorded among those already parties, or (2) he claims an interest relating to the subject of the action and is so situated that the disposition of the action in his absence may (i) as a practical matter impair or impede his ability to protect that interest or (ii) leave any of the persons already parties subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations by reason of his claimed interest. If he has not been so joined, the court shall order that he be made a party. If he should join as a plaintiff but refuses to do so, he may be made a defendant, or, in a proper case, an involuntary plaintiff. If the joined party objects to venue and his joinder would render the venue of the action improper, he shall be dismissed from the action.

All co-owners of a patent must join in bringing a suit for infringement. Chisum, *Patents*, §21.03[3], 21-295. In *Waterman v. Mackenzie*, 138 U.S. 252, 255 (1891) the court stated that patent owners have standing to sue for patent infringement, but licensees do not have standing to sue on their own. Since all co-owners have standing to sue for infringement, if all the co-owners are not joined in an infringement suit, there may be a risk that the defendant will be subject to multiple suits. *Vaupel Textilmaschinen KG v. Meccanica Euro Italia S.P.A.*, 944 F.2d 870, 875 [20 USPQ2d 1045] (Fed. Cir. 1991) (policy underlying requirement of joining owners is to prevent possibility of two suits against a single infringer.) When one co-owner sues for patent infringement, the court will find the non-joined co-owner indispensable to protect a defendant from the "justifiable fear that should [it] prevail and the court determine that the patent in suit is either invalid or not infringed, the remaining joint owners might still relitigate these issues at a later date in another costly and vexatious proceeding." *Willingham v. Star Cutter Co.*, 555 F.2d 1340, 1345 [194 USPQ 249] (6th Cir. 1977). Co-owners may avoid the inconvenience or undesirability of the joinder rule by structuring their interests so that one party is no longer in law an "owner". *Rawlings v. National Molasses Co.*, 394 F.2d 645 [158 USPQ 74] (9th Cir. 1968); Chisum, *Patents*, §21.03 [3] [d], 21-296, n. 23.

This court will consider plaintiff's motion with these standards in mind.

III. ANALYSIS

A. Is the motion timely?

Conner argues that IBM's motion to dismiss must be denied because it was not made in either a pre-answer motion under Rule 12(b)(7) or in the answer itself. IBM filed an answer to Conner's second counterclaim on October 5, 1993. IBM filed this motion to dismiss on November 12, 1993.

Rule 12(h)(2) preserves the defense of failure to join an indispensable party under Rule 19: "A defense of . . . failure to join an indispensable party under Rule 19 . . . may be made in any pleading permitted or ordered under Rule 7(1), or by motion for judgment on the pleadings, or at the trial on the merits." One does not waive the defense of failure to join an indispensable party by filing a responsive pleading. The failure to join an indispensable party can be raised at any time. *McShan v. Sherrill,* 283 F.2d 462, 464 (9th Cir. 1960); *CP Nat. Corp. v. Bonneville Power Admin.,* 928 F.2d 905, 911-12 (9th Cir. 1991), ("[t]he issue [of failure to join an indispensable party] can be properly raised at any stage in the proceedings.")

Therefore, IBM's motion is timely made.

B. Is Alps an indispensable party?

IBM contends that Alps is an indispensable party because it is a joint owner of the Morehouse '785 patent. IBM points to 1) the assignment of patent rights from Prairietek that lists Conner and Alps as joint assignees and 2) the Asset Purchase Agreement between Prairietek, Conner and Alps that confirms that Conner and Alps jointly purchased from Prairietek the Morehouse '785 patent (together with several other patents). IBM argues that as patent co-owners, Conner and Alps fall into what the Supreme Court in *Waterman* describes as the "second case".

In *Waterman,* the court states:

> The patentee or his assigns may, by instrument in writing, assign, grant, and convey either, 1st, the whole patent, comprising the exclusive right to make, use, and vend the invention throughout the United States; or, 2d, an undivided part or share of that exclusive right; or, 3d, the exclusive right under the patent within and throughout a specified part of the United States [citation omitted]. A transfer of either of these three kinds of interests is an assignment properly speaking, and vests in the assignee a title in so much of the patent itself, with a right to sue infringers; in the second case, jointly with the assignor; in the first and third cases, in the name of the assignee alone. Any assignment or transfer, short of one of these, is a mere license, giving the licensee no title in the patent, and no right to sue at law in his own name for an infringement. [citation omitted].
>
> *Waterman, supra,* 138 U.S. at 255.

IBM states that since *Waterman,* courts have held that all patent co-owners (the second case in *Waterman*) are indispensable parties under Rule 19 in suits for patent infringement. *Willingham v. Star Cutter Co.,* 555 F.2d 1340, 1343 [194 USPQ 249] (6th Cir. 1977); *Switzer Bros. Inc. v. Byrne,* 242 F.2d 909, 912 [113 USPQ 168] (6th Cir. 1957); *Hurd v. Sheffield Steel Corp.,* 181 F.2d 269, 271 [85 USPQ 147] (8th Cir. 1950).

In opposition, Conner states that Alps does not fall under the second case in *Waterman.* Citing *Gayler v. Wilder,* 51 U.S. 477, 493 (1850), Conner contends that it is not a co-owner because Alps is not on an equal footing with Conner. In *Gayler,* the court stated that "a patentee may assign his whole interest, or an undivided part of it. But if he assigns a part under this section, it must be an *undivided* portion of his *entire* interest under the patent, placing the assignee upon an *equal footing* with himself for the part assigned." Conner argues that since the Conner-Alps agreement does not give Alps the right to sue or to transfer, Alps does not have an undivided interest in these rights, and is, therefore, not an assignee, or owner of the patent and, therefore, not an indispensable party.

Conner further argues that there is no risk of multiple litigation, or even the possibility of litigation by Alps against IBM, because an entity that is prohibited by contract from suing for patent infringement lacks standing to bring such a suit.

In opposition, IBM argues that the Conner-Alps side agreement fails to provide assurance that there is no risk of multiple litigation. IBM cites *Willingham v. Star Cutter Co.,* 555 F.2d 1340 [194 USPQ 249] (6th Cir. 1977) and *Valutron, N.V. v. NCR Corp.,* 99 F.R.D. 254 [218 USPQ 1009] (S.D. Ohio 1982) for the proposition that requiring that all patent co-owners join in an action for infringement is not avoided by agreements allocating amongst a patent's owners the right to sue for infringement.

In *Star Cutter,* a patent co-owner sued a third party for patent infringement. The co-owner had a written agreement providing that either could sue for infringement in its sole discretion if the other refused or failed to join in the suit. The Sixth Circuit held that, notwithstanding the agreement, involuntary joinder was proper to protect the defendant's

justifiable fear of multiple litigation. *Id.* at 1345.

In *Valutron*, several minority owners of a patent signed an agreement restricting their ability to license, enforce, and assign the patent. *Id.* at 256. The minority owners could not enforce the patent except on written consent of the majority owners. Although the minority owners signed powers of attorney authorizing the infringement suit and agreed to be bound by any decision, the court held that *Star Cutter* was dispositive and that dismissal was required because the minority owners had neither joined in the suit voluntarily nor been joined as involuntary plaintiffs.

In opposition, Conner argues that *Star Cutter* is distinguishable because there was a risk of multiple litigation despite the agreement in *Star Cutter* while there is no risk of multiple litigation in the instant case. Conner contends that *Valutron* is inconsistent with all the case law concerning ownership. Conner cites *Refac International Ltd. v. Visa USA, Inc.*, 16 U.S.P.Q.2d 2024 (N.D. Cal. 1990) for the proposition that the right to make, sell and lease is insufficient to constitute an assignment. The court stated that an agreement's substantive provisions must be analyzed to determine whether the patentee transferred substantially all rights in the patent or whether the patentee retained significant incidents of ownership. *Id.* at 2027. The court found that a transferee's unfettered right to transfer its interest in the patent is a prerequisite to finding a transferee an assignee. *Id.* at 2029. Conner also cites *Vaupel Textilmaschinen KG v. Meccanica Euro Italia S.P.A.*, 944 F.2d 870 [20 USPQ2d 1045] (Fed. Cir. 1991) to demonstrate the overriding importance of the right to sue in determining whether an entity is an assignee.

IBM states that the cases cited by Conner are irrelevant because they deal with the circumstances under which a licensee has standing to sue. IBM contends that these cases turn on whether the license agreement grants all substantive rights in the patent including the sole right to sue alleged infringers. If so, the courts hold that the plaintiff has standing to sue for infringement. *Vaupel*, *supra*, 844 F.2d at 876. If not, plaintiff lacks standing to sue. *Calgon Corp. v. Nalco Chemical Co.*, 726 F.Supp. 983 [13 USPQ2d 1529] (D. Del. 1989); *Raber v. Pittway Corp.*, 23 U.S.P.Q.2d 1313, 1315 (N.D. Cal. 1992); *Refac Int'l Ltd. v. Visa USA Inc.*, 16 U.S.P.Q.2d 2024, 2029 (N.D. Cal. 1990). IBM argues that these cases are inapposite because the instant case does not involve standing, and there is no allegation that Conner lacks standing. IBM contends that none of these cases stands for the proposition that a record owner of a patent who has given up the exclusive right to sue for infringement ceases to be a co-owner and therefore an indispensable party.

In opposition, Conner states that the issue is not whether Conner lacks standing but whether Alps lacks standing. If Alps lacks standing to sue, Conner argues, IBM's fear of multiple litigation is groundless. Moreover, Conner argues that, in cases such as *Vaupel*, the court determines whether the provisions of Rule 19(a) have "been transgressed". In *Vaupel* the court states:

> This grant [of the right to sue] is particularly dispositive here because the ultimate question confronting us is whether Vaupel can bring suit on its own or whether Marowsky must be joined as a party. The policy underlying the requirement to join the owner when an exclusive licensee brings suit is to prevent the possibility of two suits on the same patent against a single infringer. (citations omitted.) This policy is not undercut here because the right to sue rested solely with Vaupel. . . . The district court's decision and our affirmance thereof, assure that the provisions of [rule 19(a)] have not been transgressed: complete relief can be afforded among those already parties and there is no substantial risk of a party incurring double obligations.
>
> 944 F.2d at 875-76.

Citing *Vaupel*, *supra*, 944 F.2d at 874, IBM urges the court "to examine the substance of what was granted." IBM contends that Alps is a co-owner of the patent and that the side agreement did not change that substance. Therefore, IBM argues that Alps is an indispensable party under Rule 19.

The court finds IBM's argument unpersuasive. Co-owners may avoid "the inconvenience or undesirability of the joinder rule by structuring their interests so that one party is no longer in law an "owner". Chisum, *Patents*, §21.03[3], 21-296, n. 23 *citing Rawlings v. National Molasses Co.*, 394 F.2d 645 [158 USPQ 74] (9th Cir. 1968). In *Rawlings*, plaintiff and Feed Service were the joint owners of a patent. Feed Service then assigned to plaintiff all of its rights in the patent, and plaintiff granted to Feed Service an unlimited, royalty free, non-exclusive, non-cancelable right to make, use and sell with a right to sublicense. Plaintiff brought suit for patent infringement. Defendants moved to dismiss the action contending that Feed Service was an indispensable party. The court held that Feed Service's right is not equivalent to an ownership right because

it includes no right to exclude others, which is the essence of the property interest in a patent. The court stated that "the common law and not the patent law gives an inventor the right to make, use and sell his invention. Patent law gives him the license to sue — the right to exclude others from using the invention. . . . [A]n owner of something less than monopoly rights may not sue for patent infringement." *Id.* at 647-48. The court found that "the absence of Feed Service as a party does not leave the defendants subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations (Fed.R.Civ.P. 19(a)(2)(ii)) because no matter what the outcome of this litigation there is no substantial risk of the defendants being troubled with actions brought by Feed Service. Feed Service has no capacity to sue strangers for infringement of the patent." *Id.* at 647.

According to the side agreement, confirmed by Alps' stipulation, Alps has no right to sue any infringers and cannot make Conner sue infringers. Alps does not have the right to sue an infringer even if Conner refuses to do so. Rule 19(a)(2)(ii) provides that joinder is necessary if "the person's absence . . . leave[s] any of the person's already parties subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations by reason of the claimed interest." Alps' absence does not leave IBM subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations. IBM argues that it might be subject to multiple litigation because Conner and Alps could alter the side agreement. This argument fails because IBM's fear is hypothetical. IBM has not shown that it faces a present threat of multiple litigation or inconsistent obligations.

[1] The court does not find Alps to be a necessary party because IBM does not face a substantial risk of incurring double, multiple, or otherwise inconsistent obligations.

IV. ORDER

Counterclaim defendant's motion to dismiss counterclaim plaintiff's second counterclaim for failure to join an indispensable party is denied.

District Court, N.D. Texas

KPR Inc. v. C&F Packing Co. Inc.

No. 4:93-CV-243-Y

Decided November 24, 1993

JUDICIAL PRACTICE AND PROCEDURE

1. Jurisdiction — Subject matter jurisdiction — Case or controversy (§405.0703)

REMEDIES

Non-monetary and injunctive — Declaratory judgments (§505.05)

Federal district court has jurisdiction over action for declaratory judgment of patent invalidity and non-infringement, since defendant's correspondence with plaintiff, and its actions in filing suit against third parties, were sufficient to create reasonable apprehension in plaintiff that defendant would file infringement suit, and since plaintiff used defendant's patented process and apparatus in making its product, but court will not exercise such jurisdiction, since defendant followed through on its threats in timely fashion by filing suit in another jurisdiction and thus eliminated possibility that plaintiff would incur growing potential liability, and since plaintiff engaged in forum shopping, thus precluding application of "first-to-file" rule that would otherwise require court to proceed with plaintiff's first-filed declaratory action.

JUDICIAL PRACTICE AND PROCEDURE

2. Jurisdiction — Venue; transfer of action — In patent actions (§405.1907)

Action for patent infringement, transferred from another federal district court and consolidated in present forum with action for declaratory judgment of invalidity and non-infringement of same patents, will not be returned to transferor court, even though declaratory judgment action has been dismissed, since transferee court should accept ruling on transfer as law of case and not re-transfer absent impelling or unusual circumstances or manifestly erroneous transfer order, since transfer was not manifestly erroneous, since no unusual circumstances compel re-transfer, and since purpose of transfer has not been frustrated by unforeseen post-transfer events.

Action by KPR Inc. d/b/a Rosani Food against C&F Packing Co. Inc., for declaratory judgment that defendant's patents are invalid and not infringed, and that plaintiff is not in default under any of its three agreements with defendant, consolidated with ac-

EXHIBIT 5

H
Only the Westlaw citation is currently available.

United States District Court,
S.D. New York.

E-Z BOWZ, L.L.C., Plaintiff,
v.
PROFESSIONAL PRODUCT RESEARCH CO., INC., Defendant.
PROFESSIONAL PRODUCT RESEARCH CO., INC., Third-Party Plaintiff,
v.
Deborah Lea CAVENDER, et al., Third-Party Defendants.

No. 00 Civ.8670 LTS GWG.

Sept. 5, 2003.

REPORT AND RECOMMENDATION

GORENSTEIN, Magistrate J.

*1 Defendant Professional Product Research Co., Inc. ("PPR") moves this Court pursuant to Fed.R.Civ.P. 12(b)(7) to dismiss the complaint filed by plaintiff E-Z Bowz, LLC ("E-Z Bowz") for failure to join an **indispensable** party under Fed.R.Civ.P. 19. The Court has issued separate Report and Recommendations today addressing the parties' various motions for summary judgment or partial summary judgment (the "Summary Judgment R & R") and the third party defendants' motion to dismiss PPR's third party complaint for lack of personal jurisdiction. The Summary Judgment R & R contains a complete description of the allegations in this case and its procedural history. Familiarity with that Report is assumed. This Report will provide only the background necessary for an understanding of the instant motion.

I. *BACKGROUND*

As reflected in the Summary Judgment R & R, E-Z Bowz brought this action against PPR asserting patent infringement and related trade dress and unfair competition claims alleging infringement by PPR of two patents: U.S. Patent No. 5,617,979 (the " '979 Patent") and U.S. Patent Design No. 389,998 (the " '998 Patent"). Both the original and amended complaint--as well as the motion being considered in this Report and Recommendation--were filed in the United States District Court for the Eastern District of Tennessee. The action was thereafter transferred to this Court on motion by PPR.

A. *The '979 and '998 Patents*

During the course of the application for the '979 Patent, Deborah L. Cavender included Tina Lucille Benton Slater as a co-inventor. *See* Affidavit of Deborah L. Cavender, dated February 13, 1997 (reproduced in Memorandum in Support of Defendant's Motion to Dismiss Under Rule 12(b)(7) for Failure to Join an **Indispensable** Party Under Rule 19, F.R.C.P., filed March 21, 2000 ("PPR Mem."), Ex. C), ¶¶ 1, 6-7. When the '979 Patent was issued to Deborah L. Cavender on April 8, 1997, however, Cavender was listed as the sole inventor. *See* United States Patent, dated April 8, 1997 (PPR Mem ., Ex. B). After suit was filed, the United States Patent and Trademark Office ("USPTO") granted Cavender's petition to add Slater as a co-inventor on the '979 Patent. *See* Decision on Petition under 37 CFR 1.324, undated (reproduced in E-Z Bowz' Response to PPR's Statement of Material Undisputed Facts, filed February 6, 2003, Ex. C).

On August 1, 1997, Slater signed a document in which she transferred to Cavender "her entire right, title, and interest in [the '979 Patent], including the right to sue for past, present or future infringements thereof." *See* Transfer of Rights to Patent, dated August 1, 1997 (" '979 Transfer") (reproduced in Plaintiff's Memorandum in Response to Defendant's Motion to Dismiss Under Rule 12(b)(7) for Failure to Join an **Indispensable** Party Under Rule 19, filed April 7, 2000 ("E-Z Bowz Mem."), Ex. B). Thereafter, on January 25, 1999, Cavender assigned "all of her right, title and interest throughout the world in and to [the '979 Patent], the subject matter disclosed in the patent, and any and all prior, current, or pending rights of action therein" to E-Z Bowz. *See* Assignment, dated January 25, 1999 (reproduced in E-Z Bowz Mem., Ex. D).

*2 The '998 Patent was issued on February 3, 1998 to both Cavender and Slater. *See* United States Patent, dated February 3, 1998 (reproduced in PPR Mem., Ex. A). On January 25, 1999, Cavender

assigned "all of her right, title and interest throughout the world in and to [the '998 Patent], the subject matter disclosed in the patent, and any and all prior, current, or pending rights of action therein" to E-Z Bowz. *See* Assignment, dated January 25, 1999 (reproduced in E-Z Bowz Mem., Ex. J).

On October 14, 1999--after E-Z Bowz commenced the action against PPR--Slater entered into an agreement by which she assigned to E-Z Bowz her "entire right, title and interest" in the '979 and '998 Patents and "any and all prior, current, or pending rights of action therein." *See* Assignment, dated October 14, 1999 ("Oct. 14 Assignment") (reproduced in E-Z Bowz Mem., Ex. H). This assignment was recorded in the USPTO on October 25, 1999. *See* United States Patent and Trademark Office Notice of Recordation of Assignment Document, dated January 24, 2000 (reproduced in E-Z Bowz Mem., Ex. I).

B. *The Instant Motion*

On March 21, 2000, PPR moved to dismiss the complaint for failure to join an **indispensable** party. PPR argues that E-Z Bowz "was not 'the owner' of the entire right, title and interest to the patents in suit when the Complaint was brought." PPR Mem. at 1. According to PPR, the '979 and '998 Patents were in fact owned by both E-Z Bowz *and* Slater at the time E-Z Bowz filed the complaint in this action. PPR Mem. at 1-2. PPR appears to concede, however, that Slater assigned her interest in both patents to E-Z Bowz after the infringement action was filed. *See* PPR Mem. at 2-3.

E-Z Bowz argues in response that i) it did possess the '979 and '998 Patents at the time this action was commenced and ii) even if it was not in possession of both patents at that time, Slater is not an **indispensable** party under Rule 19 given that she assigned her "entire right, title and interest" in both patents in October 1999. *See* E-Z Bowz Mem. at 1-9. Because the latter argument disposes of the motion, it is unnecessary to consider the first argument.

II. *DISCUSSION*

A. *Applicable Law*

"Fed.R.Civ.P. 19 sets forth a two-step test for determining whether the court must dismiss an action for failure to join an **indispensable** party." *Viacom Int'l, Inc. v. Kearney,* 212 F.3d 721, 724 (2d Cir.), *cert. denied,* 531 U.S. 1051 (2000). At the first step, the court must determine if the party sought to be joined "belongs in the suit, *i.e.,* whether the party qualifies as a 'necessary' party under Rule 19(a)." *Id.* (citing *Provident Tradesmens Bank & Trust Co. v. Patterson,* 390 U.S. 102, 124 (1968)) (emphasis in original). Rule 19(a) states in relevant part:

> A person who is subject to service of process and whose **joinder** will not deprive the court of jurisdiction over the subject matter of the action shall be joined as a party in the action if (1) in the person's absence complete relief cannot be accorded among those already parties, or (2) the person claims an interest relating to the subject of the action and is so situated that the disposition of the action in the person's absence may (i) as a practical matter impair or impede the person's ability to protect that interest or (ii) leave any of the persons already parties subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations by reason of the claimed interest.

*3 If the court makes a threshold determination that a party is necessary under Rule 19(a), and **joinder** is not feasible, the court must proceed to the second step and determine whether the party is "**indispensable**" under Rule 19(b). *See* *Viacom,* 212 F.3d at 725.

Rule 19(b) provides that:

> If a person as described in subdivision (a)(1)-(2) hereof cannot be made a party, the court shall determine whether in equity and good conscience the action should proceed among the parties before it, or should be dismissed, the absent person being thus regarded as **indispensable.** The factors to be considered by the court include: first, to what extent a judgment rendered in the person's absence might be prejudicial to the person or those already parties; second, the extent to which, by protective provisions in the judgment, by the shaping of relief, or other measures, the prejudice can be lessened or avoided; third, whether a judgment rendered in the person's absence will be adequate; fourth, whether the plaintiff will have an adequate remedy if the action is dismissed for nonjoinder.

If, however, the party does not "qualify as necessary under Rule 19(a), then the court need not decide whether [the party's] absence warrants dismissal under Rule 19(b)." *Viacom,* 212 F.3d at 724 (citing *Associated Dry Goods Corp. v. Towers Fin. Corp.,* 920 F.2d 1121, 1123 (2d Cir.1990)).

PPR argues that Slater is "necessary" under Rule 19(a)(2)(ii) because the filing of this suit "by less than all the owners of the patent could subject defendant to multiple, and perhaps inconsistent, liability for alleged infringement by each of the

patent owners, and deprives the court of any jurisdiction over the action." PPR Mem. at 3.

B. *Whether Slater is an **Indispensable** Party*

"Traditionally, **co-owners** of a patent were considered **indispensable** parties in a patent infringement action." *See Michaels of Oregon Co. v. Mil-Tech, Inc.*, 1995 WL 852122, at *1 (D.Or. Oct. 17, 1995) (citing *Waterman v. Mackenzie*, 138 U.S. 252, 255 (1891)). The logic of this rule was that because "all **co-owners** have standing to sue for infringement, if all the **co-owners** are not joined in an infringement suit, there may be a risk that the defendant will be subject to multiple suits." *Int'l Bus. Mach. Corp. v. Conner Peripherals, Inc.*, 1994 WL 409493, at *3 (N.D.Cal. Jan. 28, 1994) (citation omitted); *accord Michaels of Oregon*, 1995 WL 852122, at *1 (citations omitted).

Since the introduction of Fed R. Civ. P. 19 and the 1966 amendments to the rule, however, "courts are less concerned with abstract characterizations of the parties and more concerned with whether the rights of the parties can be fairly adjudicated absent **joinder** of a patent **co-owner**." *Michaels of Oregon*, 1995 WL 852122, at *2 (citations omitted); *accord Parkson Corp. v. Fruit of the Loom, Inc.*, 1992 WL 541570, at *3 (E.D.Ark.1992) ("the adoption of the 1966 amendment to Rule 19 of the Federal Rules of Civil Procedure makes clear that patent owners are not *per se* **indispensable** parties in infringement actions") (emphasis in original); *Howes v. Med. Components, Inc.*, 698 F.Supp. 574, 576 (E.D.Pa.1988) ("the adoption of the 1966 amendments to Rule 19 'makes inappropriate any contention that patent **co-owners** are *per se* **indispensable** in infringement suits" ') (quoting *Catanzaro v. Int'l Tel. and Tel. Corp.*, 378 F.Supp. 203, 205 (D.Del.1974)) (citations omitted) (emphasis in original).

*4 The Supreme Court in *Provident Tradesmens Bank & Trust Co.*, observed:

> The decision whether to dismiss (i.e., the decision whether the person missing is "**indispensable**") must be based on factors varying with the different cases, some such factors being substantive, some procedural, some compelling by themselves, and some subject to balancing against opposing interests. Rule 19 does not prevent the assertion of compelling substantive interests; it merely commands the courts to examine each controversy to make certain that the interests really exist. To say that a court "must" dismiss in the absence of an **indispensable** party and that it "cannot proceed" without him puts the matter the wrong way around: a court does not know whether a particular person is "**indispensable**" until it ha[s] examined the situation to determine whether it can proceed without him.

390 U.S. at 118-19. The modern approach thus " 'requires courts to face squarely the pragmatic substantive and procedural considerations which properly should be controlling in determining whether a party is needed for the just adjudication of a case." ' *Howes*, 698 F.Supp. at 577 (quoting *Tycom Corp. v. Redactron Corp.*, 380 F.Supp. 1183, 1186 (D.Del.1974)).

PPR argues that "[i]t is hornbook law that all of the owners of the entire right, title and interest in the patent(s) must be present before the court as plaintiffs or the court lacks jurisdiction and the case must be dismissed." PPR Mem. at 3 (citing *Waterman*, 138 U.S. at 252; *Moore v. Marsh*, 74 U.S. 515 (1869); *Switzer Bros., Inc. v. Byrne*, 242 F.2d 909 (6th Cir.1957)). As noted above, however, Slater is no longer an "owner" as she assigned her interest in the '979 and '998 Patents to E-Z Bowz after commencement of the present action. *See* Oct. 14 Assignment; *cf. Int'l Bus. Mach. Corp.*, 1994 WL 409493, at *3, * 6 ("**Co-owners** may avoid the inconvenience or undesirability of the **joinder** rule by structuring their interests so that one party is no longer in law an 'owner." ') (citations omitted).

PPR nonetheless contends that "[t]he fact that [Slater] ... quitclaims, or conveys by assignment, her interest to the patents-in-suit *after* filing of the Complaint cannot give the court jurisdiction over the action as jurisdiction depends upon the state of things existing at the time suit was brought." PPR Mem. at 3 (emphasis in original). PPR does not, however, articulate any reason why the status of the parties at the time of the filing of suit should be of any significance for purposes of the Rule 19 analysis.

Here, Slater's absence will not result in a situation where "complete relief cannot be accorded among those already parties." Fed.R.Civ.P. 19. Nor does Slater any longer "claim[ ] an interest relating to the subject of the action." *Id.* The remaining requirements of Rule 19(a) also are not met. The litigation will not "impair or impede" Slater's ability to protect her interests since she no longer has any interest in this litigation. Finally, PPR will in no way be "subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations" inasmuch as Slater no longer has an interest or any right to sue for infringement. *See Int'l Bus. Mach. Corp.*, 1994 WL 409493, at *6-*7 (rejecting

argument that party moving to dismiss for failure to join **indispensable** party was subject to multiple or inconsistent obligations where agreement provided that the party sought to be joined did not hold the right to sue infringers). Nothing in the language of Rule 19 suggests that Slater's subsequent assignment requires that she be dragooned into being part of a litigation in which she has disclaimed all interest.

*5 An analogous argument was advanced and rejected in *Procter & Gamble Co. v. Kimberly-Clark Corp.*, 684 F.Supp. 1403 (N.D.Tex.1987). The patent at issue in that case was held by Raychem, which granted plaintiff Procter & Gamble an exclusive license to the patent. *Id.* at 1403-04. Procter & Gamble then filed suit against defendant Kimberly-Clark for patent infringement, after which the defendant counterclaimed against Raychem asserting that it should be a party. *Id.* Sometime after the complaint was filed, Raychem assigned all its rights under the patent to Proctor & Gamble. *Id.* When Raychem moved to dismiss, the court rejected Kimberly-Clark's argument that the court "should consider the facts *as they existed at the time of filing suit* in determining whether Raychem was a proper party." *Id.* 1406 (emphasis in original). The court held that "even if Raychem owned the ... patent on the day suit was filed, dismissal was proper once the patent had been assigned." *Id.* at 1406- 07 (citing *Robert L. Ferman & Co. v. Gen. Magnaplate Corp.*, 33 F.R.D. 326, 329 (D.N.J.1963) and *Irving Air Chute Co. v. Switlik Parachute & Equip. Co.*, 26 F.Supp. 329, 330 (D.N.J.1939)). The court concluded that

> [a] party which assigns all of its rights and interests under a patent should not be compelled to litigate an infringement action merely because it was the patent owner on the day suit was filed and for a few days thereafter. A party which divests itself of all of its interest in a patent does not have a sufficient stake in the outcome of the controversy to require that it remain a party. Any other result would exalt form over substance.

Id. at 1407. *See also* *Rawlings v. Nat'l Molasses Co.*, 394 F.2d 645, 647 (9th Cir.1968) (rejecting argument that assignment of patent rights after litigation commenced made assignor an **indispensable** party because assignor's absence "does not leave the defendants subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations"); *Valmet Paper Mach., Inc. v. Beloit Corp.*, 868 F.Supp. 1085, 1089 (W.D.Wis.1994) (denying motion to dismiss for lack of standing where assignment conveying all rights in patent to plaintiff was executed after action was filed; to hold otherwise "would result in needless delay and needless expenditure of the parties' and the court's resources" for the plaintiff would "simply ... amend the complaint to add the assignor and then dismiss it as an unnecessary party, or simply ... reinstate the lawsuit").

While PPR cites one case that supports its position, *Switzer Bros., Inc. v. Byrne*, 242 F.2d 909 (6th Cir.1957), the "precedential value [of *Switzer*] must be doubted in light of more recent case authority holding that a patent's **co-owner** may not be an **indispensable** party to an infringement action if the shaping of relief can avoid any possible prejudice." *Proctor & Gamble Co.*, 684 F.Supp. at 1406 (citing *Windsurfing Int'l, Inc. v. Ostermann*, 100 F.R.D. 82, 83-84 (S.D.N.Y.1983)). *See generally* *Michaels of Oregon*, 1995 WL 852122, at *2 (recent courts are "more concerned with whether the rights of the parties can be fairly adjudicated absent **joinder** of a patent **co-owner**") (citations omitted).

Conclusion

*6 For the foregoing reasons, PPR's motion to dismiss for failure to join an indispenable party should be denied.

PROCEDURE FOR FILING OBJECTIONS TO THIS REPORT AND RECOMMENDATION

Pursuant to 28 U.S.C. § 636(b)(1) and Rule 72(b) of the Federal Rules of Civil Procedure, the parties have ten (10) days from service of this Report to file any objections. *See also* Fed.R.Civ.P. 6(a), (e). Such objections (and any responses to objections) shall be filed with the Clerk of the Court, with copies sent to the Honorable Laura T. Swain, 40 Centre Street, New York, New York 10007, and to the undersigned at the same address. Any request for an extension of time to file objections must be directed to Judge Swain. If a party fails to file timely objections, that party will not be permitted to raise any objections to this Report and Recommendation on appeal. *See* *Thomas v. Arn*, 474 U.S. 140 (1985).

2003 WL 22064257 (S.D.N.Y.)

END OF DOCUMENT

EXHIBIT 6

C

Michaels of Oregon Co.
v.
Mil-Tech Inc.

U.S. District Court District of Oregon

No. 95-908-MA

Decided October 17, 1995

United States Patents Quarterly Headnotes

JUDICIAL PRACTICE AND PROCEDURE
[1] Procedure -- Parties; standing (Section 410.07)
Co-owners of patent have traditionally been considered indispensable parties in patent infringement action, since all co-owners have standing to sue for infringement, and if one co-owner is not joined then defendant may risk being subject to multiple actions; however, it is possible for parties to structure their joint patent ownership agreements so that only one party retains complete ownership interest that includes right to bring infringement actions.

JUDICIAL PRACTICE AND PROCEDURE
[2] Procedure -- Parties; standing (Section 410.07)
Patent infringement defendant's motion to dismiss for failure to join co-owner of patents in suit as indispensable party is denied, since contract between co-owners gives nonparty certain ownership rights in patents, but right to file action for infringement remains exclusively with plaintiff, since nonparty's interests will be adequately protected absent its joinder, and since defendant's fear that it will incur substantial risk of double, multiple or otherwise inconsistent obligations is unfounded in view of contract and declaration by president of nonparty corporation to effect that it will not directly or indirectly contest result of any final judgment in present action.

JUDICIAL PRACTICE AND PROCEDURE
[3] Procedure -- Parties; standing (Section 410.07)
Contractual obligation of nonparty to join voluntarily in any infringement suit brought by co-owner of its patents does not require joinder of nonparty as plaintiff in present infringement action, since obligation is irrelevant to issue of whether nonparty co-owner is indispensable party, and since defendant lacks standing to seek enforcement of obligation in that it is not third party beneficiary to contract between plaintiff and nonparty co-owner.

JUDICIAL PRACTICE AND PROCEDURE
Particular patents -- General and mechanical -- Hand gun holsters
4,485,947, Cook, hand gun holster with contractive shape memory, infringement defendant's motion to dismiss denied.
4,485,948, Cook, hand gun holster with abrasion-resistant longitudinal spine, infringement defendant's motion to dismiss denied.
4,620,654, Cook, handgun holster with abrasion-resistant longitudinal spine, infringement defendant's motion to dismiss denied.

***1061** Action by Michaels of Oregon Co. against Mil-Tech Inc. for patent infringement. On defendant's motion to dismiss for lack of subject matter jurisdiction and for failure to join Bianchi International as indispensable party. Denied.

Donald B. Haslett and Bruce W. DeKock, of Chernoff, Vilhauer, McClung & Stenzel, Portland, Ore., for plaintiff.

Michael Yakimo and D.A.N. Chase, of Chase & Yakimo, Overland Park, Kan.; Alan T. McCollom and Scott A. Schaffer, of Marger, Johnson, McCollom & Stolowitz, Portland, for defendant.

Marsh, J.

Plaintiff, Michaels of Oregon, Co., filed this patent infringement action alleging that defendant, Mil-Tech, Inc., violated 35 U.S.C. Sections 1 et seq. by

making, using and selling hand gun holsters that infringe on three of plaintiff's patents. Plaintiff alleges that it is an owner of United States Letter Patent Nos. 4,485,947, and 4,485,948 granted December 4, 1984 (the '947 and '948 patents, respectively), and United States Letter Patent 4,620,654 granted November 4, 1986 (the '654 patent). Plaintiff contends that defendant is selling and shipping its infringing holsters into Oregon.

Defendant moves to dismiss plaintiff's complaint for lack of subject matter jurisdiction under Fed.R.Civ.P. 12(b)(1) and failure to join an indispensable party under Fed.R.Civ.P. 12(b)(7). Defendant contends that Bianchi International (Bianchi) is the holder of one-half of plaintiff's interest in each of the three allegedly infringed patents thus making Bianchi an indispensable party to this action. Defendant also seeks to reserve its right to file a motion to dismiss for improper venue under Fed.R.Civ.P. 12(b)(3) once plaintiff has identified the infringing holsters of defendant. For the reasons which follow, defendant's motion to dismiss is denied.

Discussion

Fed.R.Civ.P. 19 provides the conditions under which a party must be joined. Rule 19(a) states, in part:

Joinder of Persons Needed for Just Adjudication

(a) Persons to be Joined if Feasible. A person who is subject to service of process and whose joinder will not deprive the court of jurisdiction over the subject matter of the action shall be joined as a party in the action if (1) in his absence complete relief cannot be accorded among those already parties, or (2) he claims an interest relating to the subject of the action and is so situated that the disposition of the action in his absence may (i) as a practical matter impair or impede his ability to protect that interest or (ii) leave any of the persons already parties subject to a substantial risk of incurring double, multiple, or otherwise inconsistent obligations by reason of his claimed interest.

[1] Traditionally, co-owners of a patent were considered indispensable parties in a patent infringement action. *Waterman v. Mackenzie*, 138 U.S. 252, 255 (1981) (patent owners have standing to sue for patent infringement while licensees will have standing only when the patent owner joins suit). Courts have reasoned since all co-owners have standing to sue for infringement, if one of the co-owners fails to join, the defendant may risk being subject to multiple actions. *Vaupel Textilmaschinen KG v. Meccanica Euro Italia S.P.A.*, 944 F.2d 870, 875 [20 USPQ2d 1045] (Fed. Cir. 1991); *Willingham v. Lawton*, 555 F.2d 1340, 1345 [194 USPQ 249](6th Cir. 1977). It is possible, however, for parties to structure their joint ownership agreements so that only one of the parties retains a complete ownership interest in the patent, an interest that includes the right to bring actions for infringement. *Rawlings v. National Molasses Co.*, 394 F.2d 645, 647 [158 USPQ 14](9th Cir. 1968).

Since the introduction of Fed.R.Civ.P. 19, courts are less concerned with abstract characterizations of the parties and more concerned with whether the rights of the parties can be fairly adjudicated absent joinder of a patent co-owner. *Rawlings*, 394 F.2d 645 [158 USPQ 14], ***1062** *I.B.M. Corp. v. Conner Peripherals Inc.*, 30 USPQ2d 1315 (N.D.Cal. 1994), *see also Wright & Miller*, Federal Practice and Procedure, Volume 7, Section 1614, p. 204 (1986).

In *Rawlings*, the plaintiff and Feed Service were joint owners of a patent. While the litigation was pending, Feed Service assigned all of its rights in the patent to plaintiff and plaintiff gave Feed Service a 'Patent License Grant' which allowed Feed Service "an unlimited, royalty-free, non-exclusive, and non-cancelable right and license to make, use and sell the products and use the methods of said patents and each of them, and to sublicense others to do so."*Rawlings*, 394 F.2d 647. The district court dismissed the action concluding that, notwithstanding the agreement, Feed Service was an indispensable party. *Id.* at 645. The Ninth Circuit reversed holding that " [t]he absence of Feed Service as a party does not leave defendants subject to a substantial risk of incurring double, multiple or otherwise inconsistent obligations because no matter what the outcome of this litigation there is no substantial risk of the defendants being troubled with actions brought by Feed Service. Feed Service has no capacity to sue strangers for infringement of the patent."*Id.* The issue before this court is whether, absent Bianchi's joinder as a plaintiff, complete relief can be accorded and whether Mil-Tech will be subject to a substantial risk of duplicitous litigation. Defendant contends that Bianchi is an indispensable party because it holds a 50% interest in the three patents. Plaintiff argues that Bianchi is not a necessary party because a January 1, 1986 agreement between Bianchi and plaintiff provides that only plaintiff may file actions for patent infringement. [FN1] This agreement states, in part:

10. *Infringements* -- It is the understanding of the parties that MICHAELS will diligently enforce THE PATENTS against any infringement which, by its character and volume, is commercially significantly harmful to MICHAELS or BIANCHI . . BIANCHI shall fully cooperate with and assist MICHAELS in enforcing THE PATENTS against any infringement, and shall join voluntarily as a plaintiff in any suit brought by MICHAELS against any alleged infringer of THE PATENTS. . . MICHAELS and BIANCHI agree that MICHAELS shall control the conduct of any action taken to enforce THE PATENTS, including the making of any decision to file suit or not to file suit against any alleged infringer, and the making of any decision to settle and the terms of any settlement with an alleged infringer, either before of after filing suit.

Plaintiff has also submitted the declaration of Gary W. French, President of Bianchi, that states Bianchi will not directly or indirectly contest the result of any final judgment with respect to this infringement action.

[2] By its terms, I find that the contract between Bianchi and plaintiff grants Bianchi certain ownership rights in the patents, but the right to file an action for infringement remains exclusively with plaintiff. Thus, like the situation in *Rawlings,* Bianchi has no independent capacity to file a claim for patent infringement. Accordingly, Bianchi's failure to join will not prejudice defendant. In light of the French declaration, I also find that Bianchi's interests will be adequately protected absent its joinder. Further, considering the agreement and this declaration together, I find that defendant's fear that it will incur a substantial risk of double, multiple or otherwise inconsistent obligations is unfounded as Bianchi has no right to sue infringers even if Michaels refuses to do so and Bianchi has consented to be bound by the final judgment in this action. Under Fed.R.Civ.P. 19(a) I conclude that Bianchi is a dispensable party to this action.

[3] Defendant also argues that the court should enforce the contractual obligation Bianchi has to Michaels to "join voluntarily as a plaintiff in any suit brought by MICHAELS against any alleged infringer of THE PATENTS." Although this clause in the agreement relates to the rights and responsibilities between Bianchi and Michaels, it is irrelevant to the issue of whether Bianchi is an indispensable party in this action. Further, defendant lacks standing to seek enforcement of this agreement as it is not a third party beneficiary to the contract between Michaels and Bianchi.

Defendant has requested that the court preserve its right to file a motion to dismiss for improper venue under Fed.R.Civ.P. 12(b)(3) pending further discovery. This request is one the court cannot properly decide at this time. Accordingly, defendant's motion to dismiss for failure to join Bianchi as ***1063** an indispensable party (#10-1) and to reserve motion to dismiss (#10- 2) is DENIED.

IT IS SO ORDERED.

FN1 A February 20, 1986 agreement between Michaels and Bianchi transferred to Bianchi an undivided fifty percent interest in Cook U.S. Patent No. 4,485,947 and Cook U.S. Patent No. 4,485,948. On July 16, 1986, Michaels assigned to Bianchi an undivided fifty percent interest in United States patent application Serial No. 789,931 which became Cook U.S. Patent No. 4,620,654 on November 4, 1986, the date the patent issued.

D.Or.

38 U.S.P.Q.2d 1060

END OF DOCUMENT

EXHIBIT 7

H
NOTICE: THIS IS AN UNPUBLISHED OPINION.

(The Court's decision is referenced in a "Table of Decisions Without Reported Opinions" appearing in the Federal Reporter. Use FI CTAF Rule 47.6 for rules regarding the citation of unpublished opinions.)

United States Court of Appeals, Federal Circuit.

CONTINENTAL AMERICAN CORPORATION,
Plaintiff-Appellant,
v.
Leslie BARTON, Container Technologies, Inc., John C. Davis and Stephen M. Merrick, Defendants-Appellees.

No. 90-1509.

April 30, 1991.
Rehearing Denied May 28, 1991.

N.D.Tex.

AFFIRMED.

Before RICH, MAYER and CLEVENGER, *Circuit Judges.*

RICH, Circuit Judge.

DECISION

****1** Continental American Corporation (CAC) appeals from the August 7, 1990 Final Judgment of the United States District Court for the Northern District of Texas, CA 3-84-0596-T, holding, inter alia, that CAC does not have an exclusive license under United States Patent No. 4,077,588. We *affirm* the judgment in all respects.

OPINION

Section 262 of Title 35, United States Code, provides:

In the absence of any agreement to the contrary, each of the joint owners of a patent may make, use or sell the patented invention without the consent of and without accounting to the other owners.

Section 262 was a new provision in the Patent Act of 1952 codifying the law of a long line of cases. *See* 35 USCA 262 (West 1984) (Reviser's Note); R. Ellis, *Patent Assignments and Licenses* § 171 (2d ed. 1943) (Ellis) and cases cited therein. Courts have also held that a joint owner may grant licenses (of his share) to third parties without the consent of the other joint owners, and without having to account for royalties received. *See Milgram v. Jiffy Equip. Co.,* 247 S.W.2d 668, 673, 92 USPQ 436, 439 (Mo.1952) ("Each co-owner may himself use the whole of the invention as he wishes, or he may grant a non-exclusive license to outsiders to use it, and may then retain the proceeds and profits thereof."); Ellis at § § 171, 473 and cases cited therein. [FN1]

Equally well established is the self-evident concept that a joint owner of a patent cannot grant to a third party greater rights than the joint owner himself possesses. *See, e.g., Dunham v. Indianapolis & St. Louis R.R. Co.,* 8 F.Cas. 44 (N.D.Ill.1876) ("it is clear that one of the patentees cannot grant what does not belong to him, and if he gives a license or makes a contract for the use of the thing patented, he can only grant that which he has himself, and not the rights of the other patentees...."); W. Robinson, *The Law of Patents* § 773 (1890) ("the owner of an undivided interest can convey only that undivided interest"). Accordingly, the general rule has been that a grant of an *exclusive* right to practice the patented invention, which grant is greater in scope than what a single joint owner possesses, cannot be made by that single joint owner, and instead requires the consent of *all* joint owners. *See Blackledge v. Weir & Craig Mfg. Co.,* 108 F. 71 (7th Cir.1901), wherein the court stated:

The use of an invention by one of co-owners or by his licensees is not the exercise of the entire monopoly conferred by the patent. *That can be effected only by the joint or concurrent action of all owners.* The separate action of any one owner or of

his licensees can be an exercise or use only of his individual right, which, though exclusive of all besides, is not exclusive of the other patentees, their assignees or licensees.

Id. at 76 (emphasis added). *See also* Ellis at § 86 ("The general rule is that where the legal title is held jointly the entire title can be transferred only by an assignment executed by all the owners.")

**2 This case presents a novel twist to the general rule. Citing *Rail-Trailer Co. v. ACF Industries, Inc.*, 358 F.2d 15, 16-17 (7th Cir.1966), [FN2] CAC contends that 35 USC 262, by its recognition that joint owners may make an "agreement to the contrary," permitted Barton to agree in advance that Hurst could grant an *exclusive* license to a third party, thereby barring both Barton and Hurst from practicing the patented invention, without again obtaining Barton's express consent. CAC further contends that if such an agreement were oral, it would not necessarily be inconsistent with the requirement of 35 USC 261 that assignments be in writing. Thus, CAC argues, when 35 USC § § 261 and 262 are read together, there is no indication that a written assignment would necessarily "supersede" an oral agreement between joint owners that gives one joint owner the right to independently grant an exclusive license to a third party, even if the written assignment makes no mention of the oral agreement. CAC thus concludes that the district court erred in holding that, if it existed, the purported oral "final control" agreement between Hurst and Barton did not survive the written assignment to Barton, which contained no reservation of rights in Hurst to control licensing.

We need not reach the novel question of patent law that CAC presents, however. Assuming arguendo that an oral agreement allowing a single joint owner to grant an exclusive license is valid under 35 USC § § 261 and 262, and assuming further that such an oral agreement existed in this case and survived the assignment to Barton on July 1, 1979, we hold that by the time of the August 5, 1983 meeting between Hurst and the SBM representatives, that agreement had been terminated. The district court specifically found that "before Hurst began his negotiations with SBM to renew SBM's exclusive license, Barton told Hurst that he was buying a balloon-making machine for his own manufacture of balloons." Although the record contains conflicting testimony on this point, CAC has not persuaded us that the district court's fact finding was clearly erroneous. We hold that Barton's statement to Hurst effected at least a constructive, if not an express, termination of any alleged "final control" agreement. [FN3] Hurst was no neophyte when it came to dealing with patent rights. It is not unreasonable to conclude that Hurst knew or should have known that Barton's investment in his own balloon-making machine would have been to no purpose if SMB had an exclusive license, and that under such circumstances Hurst would be without authority to reinstate the exclusive license to SMB without Barton's express consent.

We have also considered the "admissions" issue raised by CAC, but find it devoid of any merit. CAC's strained argument that through their pleadings Container Technologies, Inc. (CTI) and Barton admitted "[b]y implication" that the alleged "final control" agreement was still in effect as of August 5, 1983 is directly contrary to the district court's fact finding discussed above, as well as paragraph 29 of CTI's amended counterclaim and Cross-Claim. The district court did not err in ignoring the "admissions" issue.

FN1. Although 35 USC 262 speaks in terms of a joint owner's right to "make, use or sell" the patented invention himself, it does not specifically address the joint owner's right to grant licenses to third parties. Accordingly, a leading commentator remarked that

[s]ection 262 is but a partial statement of the rights of joint owners of a patent as found in the case law. It would have been more useful and effective if it were more complete, in particular as to the rights of joint owners with respect to the granting of licenses and the disposition of their interests. P.J. Federico, *Commentary on the New Patent Act* 51 (West 1954).

FN2. We find *Rail-Trailer* inapposite. There the court merely held that one joint owner could grant an exclusive license to another joint owner, thereby barring himself from making the patented invention, without running afoul of the Sherman Act or the common law prohibition against unreasonable restraints of trade. The joint owner/licensor gave up no more than the rights he himself previously possessed. No third-party non-owners were involved, and the agreement between the joint owners (i.e.,

the license agreement itself) was written, not oral.

FN3. In light of the district court's finding that the oral "final control" agreement, if any existed, contained no element of duration, we conclude that the agreement was terminable at will by Barton. Under Texas law, contracts which contemplate continuing performance (or successive performances) and which are indefinite in duration can be terminated at the will of either party. *Clear Lake City Water Authority v. Clear Lake Utilities Co.*, 549 S.W.2d 385 (Tex.1977). To the extent that the alleged "final control" agreement established a relationship between Hurst and Barton akin to an agency, *see also* *Restatement (Second) of Agency* § 119 (1958) ("Authority created in any manner terminates when either party in any manner manifests to the other dissent to its continuance or, unless otherwise agreed, when the other has notice of dissent.")

932 F.2d 981 (Table), 1991 WL 66046 (Fed.Cir.(Tex.)), Unpublished Disposition

END OF DOCUMENT

From: "Geisler, Hope" <HGeisler@jenkens.com>
To: "'jlockhart@mailbmc.com'" <jlockhart@mailbmc.com>
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EXHIBIT 11

U.S. DISTRICT COURT - JUDICIAL CASELOAD PROFILE

DELAWARE			2002	2001	2000	1999	1998	1997	Numerical Standing U.S.	Circuit
			12-MONTH PERIOD ENDING SEPTEMBER 30							
OVERALL CASELOAD STATISTICS	Filings*		2,028	1,004	1,303	1,033	898	870	U.S.	Circuit
	Terminations		1,478	1,020	955	861	764	780		
	Pending		1,999	1,477	1,502	1,154	988	864		
	% Change in Total Filings	Over Last Year		102.0					3	1
		Over Earlier Years			55.6	96.3	125.8	133.1	1	1
Number of Judgeships			4	4	4	4	4	4		
Vacant Judgeship Months**			3.1	.0	.0	.0	11.7	3.5		
ACTIONS PER JUDGESHIP	FILINGS	Total	507	251	326	258	225	218	34	2
		Civil	462	233	307	240	198	194	18	2
		Criminal Felony	38	18	19	18	27	24	84	4
		Supervised Release Hearings**	7	-	-	-	-	-	79	2
	Pending Cases		500	369	376	289	247	216	17	2
	Weighted Filings**		462	263	298	242	221	220	51	2
	Terminations		370	255	239	215	191	195	69	4
	Trials Completed		18	16	19	13	21	15	52	2
MEDIAN TIMES (months)	From Filing to Disposition	Criminal Felony	9.8	8.0	6.6	6.0	6.2	5.8	76	4
		Civil**	8.2	12.6	10.9	11.5	10.5	11.4	21	2
	From Filing to Trial** (Civil Only)		22.5	21.0	24.0	19.7	19.0	18.7	50	4
OTHER	Civil Cases Over 3 Years Old**	Number	99	77	70	38	45	33		
		Percentage	5.4	5.5	4.9	3.5	5.0	4.2	67	3
	Average Number of Felony Defendants Filed Per Case		1.1	1.3	1.2	1.3	1.2	1.4		
	Jurors	Avg. Present for Jury Selection	33.84	32.68	35.75	30.23	29.22	29.83		
		Percent Not Selected or Challenged	24.4	19.9	28.5	15.1	18.5	9.8		

2002 CIVIL AND CRIMINAL FELONY FILINGS BY NATURE OF SUIT AND OFFENSE

Type of	TOTAL	A	B	C	D	E	F	G	H	I	J	K	L
Civil	1849	44	4	246	5	4	30	87	150	147	107	2	1023
Criminal*	150	6	4	60	-	7	32	**	4	20	1	6	10

* Filings in the "Overall Caseload Statistics" section include criminal transfers, while filings "By Nature of Offense" do not.
** See "Explanation of Selected Terms."

U.S. DISTRICT COURT - JUDICIAL CASELOAD PROFILE

			12-MONTH PERIOD ENDING SEPTEMBER 30							
TEXAS EASTERN			2002	2001	2000	1999	1998	1997	Numerical Standing	
OVERALL CASELOAD STATISTICS	Filings*		3,610	3,452	3,604	5,807	5,210	6,571	U.S.	Circuit
	Terminations		4,458	4,819	4,568	5,957	5,440	4,262		
	Pending		2,825	3,706	5,076	5,975	6,269	6,303		
	% Change in Total Filings	Over Last Year		4.6					52	8
		Over Earlier Years			.2	-37.8	-30.7	-45.1	93	9
Number of Judgeships			7	7	7	7	7	7		
Vacant Judgeship Months**			19.4	10.0	.0	11.8	.0	.0		
ACTIONS PER JUDGESHIP	FILINGS	Total	515	493	515	830	744	939	30	5
		Civil	444	427	447	762	692	883	23	4
		Criminal Felony	70	66	68	68	52	56	42	3
		Supervised Release Hearings**	1	-	-	-	-	-	94	9
	Pending Cases		404	529	725	854	896	900	41	7
	Weighted Filings**		506	507	505	478	511	504	42	5
	Terminations		637	688	653	851	777	609	10	3
	Trials Completed		22	22	28	23	32	35	32	5
MEDIAN TIMES (months)	From Filing to Disposition	Criminal Felony	8.9	8.0	6.9	6.9	6.8	6.5	67	9
		Civil**	15.0	30.9	24.3	5.9	3.9	9.0	93	9
	From Filing to Trial** (Civil Only)		14.0	15.9	15.7	14.7	14.9	15.2	9	1
OTHER	Civil Cases Over 3 Years Old**	Number	58	881	1,878	508	462	83		
		Percentage	2.4	26.1	39.6	8.9	7.7	1.4	33	6
	Average Number of Felony Defendants Filed Per Case		1.4	1.7	1.6	1.4	1.8	1.7		
	Jurors	Avg. Present for Jury Selection	32.40	32.25	35.12	29.93	28.99	27.34		
		Percent Not Selected or Challenged	33.3	35.6	35.2	34.4	28.6	29.3		

2002 CIVIL AND CRIMINAL FELONY FILINGS BY NATURE OF SUIT AND OFFENSE													
Type of	TOTAL	A	B	C	D	E	F	G	H	I	J	K	L
Civil	3110	193	4	1380	26	23	77	263	654	60	284	5	141
Criminal*	490	52	6	83	16	12	185	**	7	67	14	13	35

* Filings in the "Overall Caseload Statistics" section include criminal transfers, while filings "By Nature of Offense" do not.
** See "Explanation of Selected Terms."

	DELAWARE	EAST TEXAS
TOTAL FILINGS	**2028**	3610
ACTIONS PER JUDGESHIP	507 OF WHICH 462 ARE CIVIL	515 OF WHICH 444 ARE CIVIL
TIME IN MONTHS FROM FILING TO DISPOSITION (CIVIL)	8.2	15
TIME IN MONTHS FROM FILING TO TRIAL (CIVIL)	22.5	14
CIVIL CASES OVER 3 YEARS OLD	99	58
% OF JURORS PRESENT AT JURY SELECTION	33.84	32.4

EXHIBIT 8

A 1165319

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

May 05, 2004

THIS IS TO CERTIFY THAT ANNEXED IS A TRUE COPY FROM THE RECORDS OF THIS OFFICE OF A DOCUMENT RECORDED ON July 10, 1996

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

H. L. Jackson

H. L. JACKSON
Certifying Officer

MRD 7-10-96

07-15-1996

581/125

FORM PTO-1595 (Rev. 6-93)
OMB No. 0651-0011 (exp. 4/94)

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1. Name of conveying party(ies):
Compression Labs, Incorporated
2860 Junction Avenue
San Jose, California 95134

Additional name(s) of conveying party(ies) attached? ☐ Yes ☒ No

2. Name and address of receiving party(ies)

Name: Charger Industries, Inc.

Internal Address:

Street Address: 6262 Lusk Boulevard

City: San Diego State: CA ZIP: 92121

Additional name(s) & address(es) attached? ☐ Yes ☒ No

3. Nature of conveyance:

☐ Assignment ☐ Merger

☐ Security Agreement ☐ Change of Name

☒ Other Assignment of one-half interest

Execution Date: June 24, 1996

4. Application number(s) or patent number(s):

If this document is being filed together with a new application, the execution date of the application is:

A. Patent Application No.(s)

B. Patent No.(s)
4302775 4541012
4394774 4698672
4704628

Additional numbers attached? ☐ Yes ☒ No

5. Name and address of party to whom correspondence concerning document should be mailed:

Name: Neil S. Hirshman, Esq.

Internal Address: Kirkland & Ellis

Street Address: 200 East Randolph Drive
Suite 6100

City: Chicago State: IL ZIP: 60601

6. Total number of applications and patents involved: 5

7. Total fee (37 CFR 3.41)............$125.00

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☒ Authorized to be charged any deficiencies to deposit account; credit any overpayment

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22-0440

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Neil Hirshman — Signature

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FAX 51288122005A 84

PATENT ASSIGNMENT

THIS PATENT ASSIGNMENT ("Assignment") is made and entered into as of this 24th day of June, 1996, ("Effective Date"), by and between Compression Labs, Incorporated, a Delaware corporation, with its principal office at 2860 Junction Avenue, San Jose, California 95134 ("Assignor"), and Charger Industries, Inc. a California corporation, with its principal office at 6262 Lusk Boulevard San Diego, California 92121 ("Assignee").

WHEREAS, Assignor and Assignee are parties to that certain Asset Purchase Agreement dated as of June 7, 1996 ("Asset Purchase Agreement"), pursuant to which Assignor has agreed to sell and Assignee has agreed to purchase the assets, properties and rights pertaining to the Business as defined in the Asset Purchase Agreement;

WHEREAS, Assignor is the sole and exclusive owner of the entire right, title and interest in, to and under those United States patents identified and set forth on Schedule A and the foreign patents identified and set forth on Schedule B (the "Patents"); and

WHEREAS, Assignee wishes to acquire and Assignor wishes to assign an undivided one-half interest in and to the Patents.

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Assignor does hereby sell, assign, transfer and set over to Assignee, an

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undivided one-half interest in and to the Patents, for the United States and for all foreign countries, including any continuations, divisions, continuations-in-part, reissues, reexaminations, extensions or foreign equivalents thereof, and including the subject matter of all claims which may be obtained therefrom for its own use and enjoyment, and for the use and enjoyment of its successors, assigns or other legal representatives, as fully and entirely as the same would have been held and enjoyed by Assignor if this Assignment and sale had not been made.

Assignor authorizes and requests the Commissioner of Patents and Trademarks to record Assignee as a joint owner of the Patents, including any continuations, divisions, continuations-in-part, reissues, reexaminations or extensions thereof, and to issue any and all letters patent of the United States thereon to Assignee, as assignee of an undivided one-half interest in, to and under the same, for the use and enjoyment of Assignee, its successors, assigns or other legal representatives.

Assignor shall provide Assignee, its successors, assigns or other legal representatives, cooperation and assistance at Assignee's request and expense (including the execution and delivery of any and all affidavits, declarations, oaths, exhibits, assignments, powers of attorney or other documentation as may be reasonably required): (1) in the prosecution or defense of any interference, opposition, reexamination, reissue, infringement or

other proceedings that may arise in connection with any of the patent rights assigned herein, including, but not limited to, testifying as to any facts relating to the patent rights assigned herein and this Assignment; (2) in obtaining any additional patent protection that Assignee may deem appropriate which may be secured under the laws now or hereafter in effect in the United States or any other country; and (3) in the implementation or perfection of this Assignment.

Except with respect to Intellectual Property (as defined in the Asset Purchase Agreement), which are governed by the provisions of the Asset Purchase Agreement, the Patents are provided "AS IS" and without any warranty of any kind, including without limitation warranties of title and non-infringement.

This Assignment shall be construed and governed in accordance with the laws of the State of California without giving effect to laws concerning conflicts of laws.

This Assignment, together with the exhibits attached hereto, comprises the entire, final and exclusive understanding of the parties with respect to the subject matter herein and supersedes any previous agreement, whether oral or written, with respect to such subject matter. Notwithstanding the foregoing, to the extent any provision of this Assignment conflicts with the Asset Purchase Agreement or the License and Co-Ownership Agreement dated June __, 1996 between the parties, with respect to any